ANNUAL TECHNICAL REPORT

Integrated Regional and Urban Seismic Monitoring—Wasatch Front Area, Utah, and Adjacent Intermountain Seismic Belt

Year One: January 1, 2004–January 31, 2005

U.S. Geological Survey Cooperative Agreement No. 04HQAG0014

Dr. Walter J. Arabasz, Principal Investigator
Dr. Robert B. Smith, Co-Principal Investigator
Dr. James C. Pechmann, Co-Investigator
Dr. Kristine L. Pankow, Co-Investigator
Relu Burlacu, Co-Investigator

University of Utah
Department of Geology and Geophysics
135 South 1460 East, Room 705 WBB
Salt Lake City, UT 84112-0111
Tel: (801) 581-6274 Fax: (801) 585-5585
E-mail: arabasz@seis.utah.edu
URL: www.seis.utah.edu

USGS Project Officer: Dr. John Unger
USGS Administrative Contracting Officer: Brenda J. Donnelly

Program Element: Seismic Networks
Key Words: Regional Seismic Hazards, Real-time Earthquake Information, Seismotectonics, Engineering Seismology

March 31, 2005

Research supported by the U.S. Geological Survey (USGS), Department of the Interior, under USGS award number 04HQAG0014. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

Integrated Regional and Urban Seismic Monitoring—Wasatch Front Area, Utah, and Adjacent Intermountain Seismic Belt
04HQAG0014

W. J. Arabasz, R. B. Smith, J. C. Pechmann, K. L. Pankow, and R. Burlacu

University of Utah
Department of Geology and Geophysics
135 South 1460 East, Room 705 WBB
Salt Lake City, UT 84112-0111
Tel: (801) 581-6274 Fax: (801) 585-5585
E-mail: arabasz@seis.utah.edu
URL: www.seis.utah.edu

Program Element: Seismic Networks
Key Words: Regional Seismic Hazards, Real-time Earthquake Information, Seismotectonics, Engineering Seismology

Non-technical Summary
January 1, 2004 – January 31, 2005

This cooperative agreement provides major support for urban and regional seismic monitoring in Utah and neighboring areas. During the report period we operated and improved a real-time earthquake information system in Utah's seismically hazardous Wasatch Front urban corridor. By the end of January 2005, a total of 76 strong-motion stations were operating in our urban network as part of the Advanced National Seismic System (ANSS) to meet needs for emergency response and earthquake engineering. More than 1,200 earthquakes were located in our study region during the report period; nine had a magnitude of 3.0 or larger, and 17 were reported felt. The largest local earthquake was a shock of magnitude 4.1 on November 7, 2004, near the Colorado-Utah border, 31 km (19 mi) west of Naturita, CO. Many of our activities during the report period were to help build elements of the ANSS in Utah, in the Intermountain West region, and nationally.

Integrated Regional and Urban Seismic Monitoring—Wasatch Front Area, Utah, and Adjacent Intermountain Seismic Belt
04HQAG0014

W. J. Arabasz, R. B. Smith, J. C. Pechmann, K. L. Pankow, and R. Burlacu

University of Utah
Department of Geology and Geophysics
135 South 1460 East, Room 705 WBB
Salt Lake City, UT 84112-0111
Tel: (801) 581-6274 Fax: (801) 585-5585
E-mail: arabasz@seis.utah.edu
URL: www.seis.utah.edu

Program Element: Seismic Networks
Key Words: Regional Seismic Hazards, Real-time Earthquake Information, Seismotectonics, Engineering Seismology

Summary
January 1, 2004 – January 31, 2005

The cooperative agreement identified here, combined with funding from the State of Utah, provided major support for the operation of (1) the University of Utah Seismograph Stations' (UUSS) regional and urban seismic network and (2) a regional earthquake-recording and information center on the University of Utah campus in Salt Lake City. In late 2004, the USGS changed the end date of Year 1 of the cooperative agreement (the period of this report) from December 31, 2004 to January 31, 2005.

At the end of January 2005, UUSS operated and/or recorded 207 stations (~50% short-period, ~35% strong-motion, ~15% broadband, with some stations having multiple sensor types); a total of 490 data channels were being recorded. USGS support is focused on the seismically hazardous Wasatch Front urban corridor of north-central Utah, but also encompasses neighboring areas of the Intermountain Seismic Belt. During the report period, project efforts involved: (a) continued development of a real-time earthquake information system in the Wasatch Front area as an element of an Advanced National Seismic System (ANSS); (b) timely study of new data acquired with our modernized network; (c) ongoing network operations; and (d) miscellaneous related activities. No new ANSS instrumentation was allocated to our network in FY 2004 because of stagnant ANSS funding.

Notable accomplishments during the report period included: (1) improving the performance of our Earthworm system (including upgrading to version 6.2) for real-time earthquake monitoring and automated alerts; (2) developing ShakeMap scenarios for magnitude 7.0 earthquakes on the Salt Lake City and Brigham City segments of the Wasatch fault for emergency-response exercises and planning; (3) project planning for extending ShakeMap capabilities to the entire Utah region; (4) revising and finalizing a manuscript for the *Bulletin of the Seismological Society of America* on triggered seismicity in Utah caused by the 2002 M_w 7.9 Denali Fault earthquake; (5) stabilizing software and digital-telemetry components associated with our urban strong-motion stations; (6) refining methods for determining magnitudes of very small earthquakes in our network; (7) providing technical assistance to regional seismic networks in the ANSS Intermountain West Region and elsewhere; (8) participating in working groups to develop the next generation of ground-shaking hazard maps in Utah; and (9) participating in many ANSS implementation activities—local, regional, and national.

During the report period, we detected and analyzed approximately 5,900 seismic events, including local earthquakes, teleseismic and regional earthquakes, and blasts. A total of 2,075 earthquakes were located within and near our regional seismic network—including 1,265 within the Utah region, of which 1,002 were within the Wasatch Front area (38° 55'–42° 30' N, 110° 25'–113° 10' W). Nine earthquakes of magnitude 3.0 and larger occurred in the Utah region during the report period. Seventeen earthquakes were documented as felt. The largest earthquake was a shock of magnitude (M_L) 4.1 that occurred at 06:54 UTC on November 7, 2004, 31 km (19 mi) W of Naturita, CO, near the Colorado-Utah border.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

INTRODUCTION

This technical report summarizes results and accomplishments under this cooperative agreement during the period January 1, 2004–January 31, 2005. During the report period, project efforts involved: (a) continued development of a real-time earthquake information system in the Wasatch Front area as an element of an Advanced National Seismic System (ANSS); (b) timely study of new data acquired with our modernized network; (c) ongoing network operations; and (d) miscellaneous related activities.

General Background

This cooperative agreement, combined with funding from the State of Utah, provided major support for the operation of (1) the University of Utah Seismograph Stations' (UUSS) regional and urban seismic network (Figs. 1–3) and (2) a regional earthquake-recording and information center on the University of Utah campus in Salt Lake City. No new ANSS instrumentation was allocated to our network in FY 2004 because of stagnant ANSS funding.

During the past four years the UUSS regional/urban seismic network has become a model outside of California for locally implementing ANSS. This is because of successes in (1) integrating weak- and strong-motion recording and (2) developing an effective real-time earthquake information system in advance of the 2002 Salt Lake City Winter Olympics. Ours was the first network outside California to locally customize and produce automatic ShakeMaps, successfully implement the Earthworm Oracle Database for earthquake recording and alarms, engineer point-to-multipoint digital telemetry, and complete *in-situ* calibration of all our broadband and strong-motion stations. We are meeting every ANSS network performance objective listed in Attachment A of *Program Announcement 04HQPA0002* for USGS-funded seismic networks—excepting technical standards yet to be established by the USGS/ANSS.

At the end of January 2005, UUSS operated and/or recorded 207 stations (~50% short-period, ~35% strong-motion, ~15% broadband, with some stations having multiple sensor types); a total of 490 data channels were being recorded. USGS support is focused on the seismically hazardous Wasatch Front urban corridor of north-central Utah, but also encompasses neighboring areas of the Intermountain Seismic Belt. State funds contribute significantly to network-operation costs in the Wasatch Front area, and they support network operations in Utah outside this area.

Information products and services produced under this cooperative agreement include rapid earthquake alert, a Web site with near-real-time earthquake information, earthquake catalogs (issued on a quarterly basis in preliminary form and periodically in finalized form), automated transfer of hypocentral, waveform, and arrival-time data to other outlets prescribed by the USGS for broad access, and extensive expert assistance to individuals and groups in earthquake education and awareness, public policymaking, planning and design, and hazard and risk assessment.

Scientific objectives include the characterization of tectonic framework and earthquake potential, surveillance of space-time seismicity and characteristics of small-to-moderate earthquakes (for understanding the nucleation of large earthquakes in the region), improved ground-motion modeling for engineering applications, and the documentation and evaluation of various earthquake-related parameters for accurate hazard and risk analyses. Some scientific results are reported to the USGS under separate research awards.

Earthquake Hazards and Risk in the Study Region

Earthquakes pose the greatest natural threat for destruction of life and property in Utah. On a national level, the relative hazard and risk of Utah's Wasatch Front area led the USGS to target it for an urban strong-motion network of 500 instruments in its 1999 report to Congress for an Advanced National Seismic System (ANSS) (USGS Circular 1188). The Federal Emergency Management Agency (FEMA) ranks Utah seventh in the Nation in absolute risk and sixth in relative risk when one takes the average of the average annualized earthquake loss to the replacement value of the building inventory (FEMA, 2000).

Tectonically, the Wasatch Front area (see Figs. 1–3) occupies an active segment of the Intermountain Seismic Belt (ISB)—roughly centered on the 343-km-long Wasatch fault zone (Fig. 4). Diffuse shallow seismicity, Holocene normal faulting, and episodic surface-faulting earthquakes of M6.5 to M7.5+ characterize the area. The Wasatch fault is notable as the longest continuous, active normal fault in the United States (10 discrete segments)—with five central segments between Brigham City and Nephi (just off the bottom of the map in Fig. 2) having an average length of about 50 km, Holocene slip rates of 1–2 mm/yr, and average recurrence intervals ranging from about 1,300 to 2,800 years (Machette et al., 1991; McCalpin and Nishenko, 1996). One of the most active segments is the Salt Lake City segment, which has produced large, M~7, surface-faulting earthquakes on the average of once every 1,350±200 years during the past 6,000 years, with the last one occurring 1,230±60 years ago (Black et al., 1995; McCalpin and Nishenko, 1996; McCalpin and Nelson, 2000).

The National Seismic Hazard Maps of Frankel et al., (1996, gridded data) indicate relatively high ground-shaking hazard for the Wasatch Front—reflected, for example, by the following values of peak ground acceleration for downtown Salt Lake City (zip code 84103) for specified probabilities of exceedance: 10% in 50 yr =0.29 g; 5% in 50 yr = 0.53 g; 2% in 50 yr = 0.87 g.

More than three-quarters of Utah's population and economy are concentrated in the Wasatch Front area, literally astride the five most active segments of the Wasatch fault. Population in the Greater Wasatch Area, most densely concentrated in the Ogden-Salt Lake City-Provo urban corridor, is growing rapidly from a 1995 base of 1.6 million and is projected to reach 2.3 million by 2010 and 3.1 million by 2030 (QGET Work Group, 2003). Based on data for 1997–2001, total new construction in the Greater Wasatch Area has averaged $3.3 billion per year (Isaacson, 2002). From 2000 to 2030, a billion dollars per year will be spent on new infrastructure for transportation and water (QGET Work Group, 2003).

Estimated direct economic losses to buildings and lifelines for a magnitude 7.5 earthquake in Salt Lake County are approximately $12 (±3) billion (in 1997 dollars) (Rojahn et al., 1997). If one adds indirect economic and social losses (casualties, displaced households, and short-term shelter needs), total losses could be 20 percent higher, putting the total in the range of $11 billion to $18 billion.

Contributions and Benefits to NEHRP

Both NEHRP and the USGS benefit greatly from this project in the form of (1) significant sharing of costs by the state of Utah under this state-federal partnership and (2) wide-ranging activities by the University of Utah seismologists, which effectively relieve the USGS from having to meet the same first-order needs in this region. (Unlike other NEHRP focus regions such as southern and northern California, the Pacific Northwest, and New Madrid, there are no collocated USGS earthquake scientists here.) Data and information from our regional/urban network provide essential underpinnings for earthquake engineering, emergency response, and science in our region. The USGS also benefits from the leadership role we are playing in implementing ANSS both in the Intermountain West region and nationally.

State-Federal Partnership

The state of Utah currently provides roughly 40% of the total costs for seismic network operations and associated earthquake research in the Utah region. USGS support is focused on the seismically hazardous Wasatch Front urban corridor of north-central Utah (see Fig. 3), within which more than three-quarters of Utah's population and economy is concentrated. About half of the annual funding from the state of Utah contributes to seismic-network operations in the Wasatch Front area; the remainder, towards network operations in Utah outside the Wasatch Front area and for general earthquake research in Utah. (Separate support is provided to the University of Utah by the USGS Volcano Hazards Program for the Yellowstone seismic network.)

The strength of the combined state-federal funding of our network is that it has allowed us to balance the practical necessities of a regional seismological approach (e.g., Fig. 3) along with careful attention to Utah's urban corridor. Federal funding also gives us essential flexibility to respond to and study significant earthquakes in other parts of the ISB outside of Utah, where our state funds cannot appropriately be used. We routinely monitor virtually the entire ISB from Yellowstone National Park on the north to the Utah-Arizona border (Fig. 3). Our responsibility for producing earthquake catalogs, however, is limited to the Utah and Yellowstone regions.

Regional/Urban Seismic Network

Figures 1 and 2 together with Tables 1, 2, and A-1 (Appendix A) summarize essential information for the University of Utah's urban/regional seismic network, which included 207 stations (490 channels) at the end of January 2005. The overall distribution of conventional broadband and short-period stations in the Utah region is effectively shown in Figure 1. Larger-scale maps in Figure 2 show better the locations of strong-motion stations installed as part of the new urban network in the Wasatch Front area.

The urban/regional network consists of: 133 stations within our traditional Wasatch Front study area (dashed rectangle, Fig. 1); an additional 17 stations that provide expanded coverage of the Utah region; and another 57 stations covering neighboring parts of the Intermountain Seismic Belt, mostly from southeastern Idaho to Yellowstone National Park. Separate USGS support is provided for the Yellowstone network. As indicated in Table 2 (see also Table A-1, Appendix A), 43 of the 207 stations were maintained by other institutions—including 14 broadband stations operated by either the USGS, Sandia National Lab, or Lawrence Livermore National Lab as part of the U.S. National Seismic Network. The University of Utah handled the field repair and maintenance of 165 stations, 115 of which were sponsored by the USGS under this award. (One station, DUG, has collocated USGS- and UUSS-maintained equipment.)

In March 2004 we were asked by ANSS managers to respond to a list of "20 Questions" to characterize the relative performance of our seismic-network operations. Our responses are included here in Appendix B.

Data Management Practices and ANSS Data Policy

Data management practices in our regional/urban seismic network are consistent with ANSS data policy, and we have agreed to adhere to the "Advanced National Seismic System Elements of Data Policy" adopted by the ANSS National Implementation Committee in December 2003. In particular:

- All digitally-recorded waveforms from stations we maintain and operate (channel types EH, EN, HH, EL), dating back to 1981, are archived at the IRIS DMC.

- All UUSS instrument responses, dating back to the start of digital recording in 1981, are archived at the IRIS DMC.

- Continuous waveform data from all stations we maintain and operate (EH, EN, HH, EL) have been submitted to the IRIS DMC on a daily basis since June 2002. Currently, the IRIS DMC retrieves data from our Earthworm System wavetanks several times per day. Beginning with a different system, continuous archiving at the IRIS DMC of waveform data from our broadband stations began on June 19, 2001, and on April 19, 2001, for continuous waveform data from our strong-motion stations.

- Our network promptly reports automated and analyst-reviewed earthquake locations into the QDDS; earthquake catalog updates are automatically submitted to the CNSS/ANSS catalog four times per day (Monday through Friday).

RESULTS AND ACCOMPLISHMENTS

Overview of Seismicity

During the report period, we detected and analyzed 5,896 seismic events. Of these 47 percent were local earthquakes within or near our regional seismic network, 35 percent were regional earthquakes and teleseisms, and 18 percent were blasts. A total of 2,075 earthquakes were located in the Intermountain Seismic Belt, including 1,265 within the Utah region (Fig. 4) and 1,002 within our standard Wasatch Front region (38° 55'–42° 30' N, 110° 25'–113° 10' W). Nine earthquakes of magnitude 3 or larger occurred in the Utah region (Fig. 5, Table 3). The largest earthquake was a shock of magnitude (M_L) 4.1 that occurred at 06:54 UTC on November 7, 2004, 31 km (19 mi) W of Naturita, CO, near the Colorado-Utah border.

From January 1, 2004 through January 31, 2005, seventeen earthquakes in the Utah region were documented as felt (Table 4). During this same period, we issued seven press releases immediately after earthquakes in the Utah region that were either felt by many or were larger than a set threshold magnitude of 3.5. Mining-induced seismicity accounted for about 25 percent of the earthquakes located in the Utah region during this period. A total of 313 shocks ($M \leq 2.6$) were located in known areas of underground coal-mining within an arcuate zone extending counterclockwise from east of Price to 100 km southwest of it (Fig. 4).

Real-Time Earthquake Information System

During the report period, efforts were intentionally focused on making our real-time information system more robust. Accomplishments included the following:

***Earthworm* —** Our Earthworm system (hardware and software) for real-time earthquake monitoring and automated alerts currently runs on 13 computers and is in a constant state of development. Work done on this system, in addition to routine maintenance and monitoring of the system performance, included: modifications to accommodate new stations and changes in instrumentation and/or telemetry at existing stations; transfer of Earthworm software for K2 strong-motion instrument telemetry from multiple PCs to a SUN workstation; and progress towards completing the installation of Earthworm v6.2. Earthworm v6.2 is now running on all of our Earthworm machines except for (1) the PC which digitizes data from analog telemetry stations and (2) the machines on the primary system which interact with the Oracle database. Our testing and configuration of Earthworm v6.2 on the latter machines were delayed for more than a year by a bug in the Earthworm database software. The bug was finally fixed by David Kragness, a software consultant to the USGS, in late 2004.

***ShakeMap* —** We continued to implement ShakeMap and customize it for use in the Wasatch Front urban corridor. We also worked with the ShakeMap Working Group, contributing code. ShakeMap developments included fully incorporating FY 2003 stations, upgrading our in-house user's manual, adding a third USGS server to our transfer list, and installing and testing the new version 3.0 on our backup machine. Major efforts were directed towards generating and posting scenario earthquake ShakeMaps to our Web site. Scenarios were posted for two events: (1) an M7 earthquake on the Salt Lake City segment of the Wasatch fault and (2) an M7 earthquake on the Brigham City segment of the Wasatch fault. The Salt Lake City segment scenario was a central theme in an article for City Weekly (a local weekly circular). The Brigham City segment scenario was developed and used for a Utah Geological Survey earthquake preparedness training exercise. Results of the scenario were automatically emailed to the exercise participants at a prescribed time and posted to the UUSS Web site, mimicking the procedure following a real earthquake. During 2004 we also met with the Utah Department of Emergency Services and a FEMA representative to plan for the next stage of ShakeMap developments in Utah. Both agencies expressed the desire (1) that ShakeCast be installed so that ShakeMaps can automatically be incorporated into HAZUS, and (2) that ShakeMap coverage be expanded to the entire state of Utah. We have completed planning to meet these two requests.

***Urban strong-motion stations* —** Our network currently has a total of 76 ANSS strong-motion stations; 75 of these were installed during 2000–2003, and the latest was installed in December 2004 on the grounds of the Utah State Capitol, which currently is undergoing a major seismic retrofit. During 2004, considerable effort went into stabilizing digital-radio subnets within our real-time urban network that use Time Division Multiple Access (TDMA) technology and into beta testing REF TEK software. Performance problems with the TDMA subnets were finally resolved by replacing routers with terminal servers at point-to-multipoint telemetry nodes. To reduce telemetry costs, frame-relay telephone circuits at seven strong-motion stations were replaced by either digital radio telemetry or newly available and less expensive DSL lines. We continued to record real-time data streams from four strong-motion stations operated in the Wasatch Front area by the USGS National Strong-Motion Program (NSMP). In addition, we use an import protocol to automatically receive from NSMP both parametric data (in XML format) and waveform data from other NSMP strong-motion stations in the Wasatch Front area that have telephone connections to Menlo Park, CA. The NSMP data usefully contribute to ShakeMaps in Utah.

Miscellaneous Network-Related Studies

***Triggered seismicity following the Denali Fault earthquake* —** Following the Denali fault, Alaska, earthquake on November 3, 2002, the University of Utah's regional seismic network recorded an abrupt increase in local microseismicity during the first 24 hours (>10 times the average background level), beginning with the arrival of the surface waves; elevated seismicity continued for tens of days throughout much of Utah's main seismic belt. The Denali fault earthquake triggered seismicity not only in Utah, but also throughout much of the western United States. During 2004 a manuscript describing the observations made in Utah was revised and published in the Bulletin of the Seismological Society of America (Pankow et. al., 2004). In addition to the article, we also generated an accompanying electronic supplement that contains the earthquake catalog we used in our analysis. A second, related, study that we participated in was a regional analysis of the peak dynamic stresses in the western United States from the Denali fault earthquake and the role of source directivity in enhancing these stresses. This study was also published in the special volume on the Denali fault earthquake (Velasco et. al., 2004).

***Receiver-function analysis* —** In collaboration with a University of Utah graduate student and others, we have been analyzing teleseismic earthquakes recorded by both regional broadband instruments and the ANSS urban strong-motion network. The student (now a post-doc) has been migrating these data to image crustal/upper-mantle structure. Preliminary results were presented at the 2003 Fall AGU meeting (Sheng et al., 2003) and a paper on this work is in preparation.

***Coal-mining-induced seismicity* —** We continued studies of seismicity induced by underground coal mining in east-central Utah (Arabasz et al., 2004a,b) in order to serve the needs of (1) mining engineers and mine operators concerned with mine safety and (2) decision-makers dealing with the potential hazards of mining-induced seismicity (MIS) to off-site structures and facilities. The studies involved cooperative research with the USGS and the U.S. Bureau of Reclamation, including ground-motion studies of the MIS in order to evaluate the hazard of surface ground shaking and to estimate the probable maximum magnitude of MIS for engineering use. During 2004 we began partnerships with three coal mines in Utah's Book Cliffs mining district. Above each mine, we cooperatively installed one 4-component seismograph (3-component accelerometer plus a vertical-component short-period velocity sensor) with continuous telemetry to our network operations center. The instrumentation provides mine operators with continuous Webicorder records online, improved locations of MIS at the mine sites, and ground-motion data for the larger events.

Accomplishments in Ongoing Network Operations

Noteworthy accomplishments during the report period included the following:

***Revision of coda magnitudes in the UUSS catalog, 1981–2002* —** As part of a major project to correct systematic time-dependent coda-magnitude (M_C) errors in the UUSS earthquake catalog, 1981-2002, we measured additional signal durations for 4,238 earthquakes in this catalog for which less than three such measurements were available from stations with known gains. We tried unsuccessfully to measure additional signal durations for nearly 1,500 other earthquakes. This work was necessary because the gain corrections we began routinely applying to our duration measurements in 2003 are sometimes unstable, and this problem is difficult to recognize for earthquakes with less than three duration measurements. Final quality control checks on the revised M_Cs are under way.

***Assistance to other seismic networks* —** Since a meeting in April 2003 with operators of the Puerto Rico seismic network during SSA2003 in San Juan, Puerto Rico, we have been providing technical advice and help on expansion and modernization of their network. During 2004 this assistance was in the form of (1) providing technical help for configuring REF TEK-130s, (2) providing examples of response files in SEED format for common instrumentation, and (3) providing SAC macros for manually determining peak ground accelerations and peak ground velocities from strong-motion data and formatting these measurements for use in ShakeMap. We also provided a customized ShakeMap module for "cancel" to the University of Washington and provided our in-house ShakeMap user's guide to the University of Memphis. Other assistance included providing remote maintenance of the Northern Arizona University Earthworm system, providing Webicorder displays for newly-installed USGS stations in western Wyoming, and supplying instrument siting contacts for southern Utah to Rick Aster for the RISTRA PASSCAL experiment.

***Archiving waveform data* —** All digital waveform data collected by the University of Utah regional seismic network during the report period were submitted to the IRIS DMC in SEED format.

Submisson of earthquake catalog data to ANSS information outlets — During the report period, Earthworm automatic (non-human-reviewed) hypocenters and magnitudes for earthquakes of magnitude 3.0 and larger in our authoritative regions (Utah and Yellowstone National Park)—2.5 and larger in the Wasatch Front urban corridor—were automatically submitted to the QDDS. Analyst-determined hypocenters and magnitudes for all earthquakes in our authoritative regions were submitted to the QDDS as they were completed, using software that we improved during the report period. These same data were automatically submitted to the ANSS catalog four times per day during the Monday-Friday work week. Events of $M \geq 1.0$ submitted to the QDDS are automatically posted on the ANSS RecentEqs Web pages.

Miscellaneous

***ANSS implementation activities* —** Besides involvement in the ShakeMap Working Group and helping other seismic networks, we participated in many ANSS implementation activities during the report period. Among others, these included coordination of ANSS advisory committees and other planning in the Intermountain West (IMW) Region, service on the ANSS National Implementation and Technical Integration committees, chairing a working group to develop an evolutionary architecture for ANSS, activism in securing Congressional support for increased ANSS funding, and field exploration and noise testing to site a new ANSS national backbone station near Cedar City in SW Utah.

***Utah earthquake hazards working groups* —** In February 2004 we presented two invited talks at a Utah earthquake hazards conference sponsored by the USGS and the Utah Geological Survey and also participated in associated workshops. Four seismologists in our network group are serving on a 15-member Utah Ground-Shaking Working Group, which is planning the development of the next generation of ground shaking hazard maps in Utah. Two are also serving on a Utah Quaternary Fault Parameter Working Group. These activities enable close coordination between our UUSS/ANSS urban strong-motion network and researchers addressing local ground-motion-related issues.

AVAILABILITY OF DATA

All seismic waveform data archived by the University of Utah Seismograph Stations are available upon request directly from our office (typically delivered to the user in SAC ASCII or binary format). Alternatively, waveform data can be retrieved from the IRIS DMC using their SeismiQuery Web tool at *<http://www.iris.washington.edu/SeismiQuery>* (delivered in a variety of formats). Earthquake catalog data for the Utah region are available (1) via anonymous ftp *<ftp.seis.utah.edu/pub/UUSS_catalogs>*, (2) via the Advanced National Seismic System's composite earthquake catalog *<http://quake.geo.berkeley.edu /cnss/cnss-catalog.html>*, or (3) by e-mail request to *webmaster@seis.utah.edu*. See also the University of Utah Seismograph Stations homepage at *<http://www.seis.utah.edu>*. The contact person for data requests is Relu Burlacu, tel: (801) 585-7972; e-mail: *burlacu@seis.utah.edu*.

REFERENCES CITED

Arabasz, W. J., S. J. Nava, M. K. McCarter, K. L. Pankow, J. C. Pechmann, J. Ake, and A. McGarr (2005a). Coal-mining seismicity and ground-shaking hazard**:** A case study in the Trail Mountain area, Emery County, Utah, *Bull. Seism. Soc. Am.* **95**, 18–30.

Arabasz, W. J., J. Ake, M. K. McCarter, and A. McGarr (2005b). Estimation of probable maximum magnitude for coal-mining-induced seismicity in Utah—A Utah case study, *Proceedings, 34th Annual Institute, International Society of Mine Safety Professionals Critical Issues Conference*, Salt Lake City, Utah, in press.

Black, B. D., W. R. Lund, and B. H. Mayes (1995). Summary of new information from the South Fork Dry Creek site, Salt Lake County, Utah, in *Environmental and Engineering Geology of the Wasatch Front Region*, W. R. Lund, editor, *Utah Geol. Assoc. Publ. 24*, 11-30.

Frankel, A., C. Mueller, T. Barnhard, D. Perkins, E. V. Leyendecker, N. Dickman, S. Hanson, and M. Hopper (1996). National Seismic Hazard Maps: Documentation June 1996, *U.S. Geol. Surv. Open-File Rept. 96-532*.

FEMA (2000). *HAZUS 99 Estimated Annualized Earthquake Losses for the United States*, Federal Emergency Management Agency, *FEMA 366*, Washington, DC, 32 pp.

Isaacson, A.E. (2002). Utah's economy: Slow growth during 2001, *Utah Economic and Business Review* **62** (11 & 12), 1–15.

Machette, M. N., S. F. Personius, A. R. Nelson, and D. P. Schwartz (1991). The Wasatch fault zone, Utah—segmentation and history of Holocene earthquakes, *J. Struct. Geol.* **13** (2), 137-149.

McCalpin, J. P. and C. V. Nelson (2000). Long recurrence records from the Wasatch fault zone, Utah, Final Technical Report, Contract 99HQGR0058, National Earthquake Hazards Reduction Program, U.S. Geological Survey, 61 pp.

McCalpin, J. P. and S. P. Nishenko (1996). Holocene paleoseismicity, temporal clustering, and probabilities of future large (M>7) earthquakes on the Wasatch fault zone, Utah, *J. Geophys. Res*. **101** (B3), 6233-6253.

Pankow, K. L., S. J. Nava, J. C. Pechmann, and W. J. Arabasz (2004). Triggered seismicity in Utah from the November 3, 2002, Denali Fault earthquake, *Bull. Seism. Soc. Am*. **94** (6B), S332–S347.

QGET Quality Growth Efficiency Tools Work Group (2003). 2003 baseline scenario for the Greater Wasatch Area of Utah, <http://governor.utah.gov/dea/ 2003BaselineWEB.pdf>

Rojahn, C., S. A. King, R. E. Scholl, A. S. Kiremidjian, L. D. Reaveley, and R. R. Wilson (1997). Earthquake damage and loss estimation methodology and data for Salt Lake County, Utah (ATC-36), *Earthquake Spectra* **13** (4), 623-642.

Sheng, J., G. T. Schuster, K. L. Pankow, J. C. Pechmann, and R. L. Nowack (2003). Coherence-weighted wavepath migration of teleseismic data (abstract), *Eos*, *Trans. Am. Geophys. Union* **84** (46), Fall Meet. Suppl., Abstract S11E-0344.

Velasco, A. A., C. J. Ammon, J. Farrell, and K. Pankow (2004). Rupture directivity of the 3 November 2002 Denali fault earthquake, *Bull. Seism. Soc. Am.* **94** (6B), S293–S299.

REPORTS AND PUBLICATIONS

Arabasz, W. J., S. J. Nava, M. K. McCarter, K. L. Pankow, J. C. Pechmann, J. Ake, and A. McGarr (2005a). Coal-mining seismicity and ground-shaking hazard**:** A case study in the Trail Mountain area, Emery County, Utah, *Bull. Seism. Soc. Am.* **95**, 18–30.

Arabasz, W. J., J. Ake, M. K. McCarter, and A. McGarr (2005b). Estimation of probable maximum magnitude for coal-mining-induced seismicity in Utah—A Utah case study, *Proceedings, 34th Annual Institute, International Society of Mine Safety Professionals Critical Issues Conference*, Salt Lake City, Utah, in press.

McGarr, A., J. B. Fletcher, and W. J. Arabasz (2004). Seismic hazard to the Joes Valley Dam, central Utah, due to nearby coal-mining-induced earthquakes, (abstract), *Seism. Res. Letters* **75** (3), 444.

Pankow, K.L. and R.L. Bruhn (2004). Re-examining the transition from the Basin and Range tectonic province to the Middle Rocky Mountains tectonic province (abstract), EarthScope: Basin and Range Meeting, Tahoe, CA.

Pankow, K. L. and J. C. Pechmann (2004a). Determination of low-strain amplification factors in the Salt Lake Valley, Utah, using ANSS data (abstract), *Basin and Range Province Seismic Hazards Summit II, Program and Abstracts*, Reno-Sparks, Nevada, May 16–19, 2004, 122–123.

Pankow, K. L. and J. C. Pechmann (2004b). Determination of low-strain site amplification factors in the Salt Lake Valley, Utah, using ANSS Data (abstract), *Eos, Trans. Am. Geophys. Union* **85** (47), Fall Meet. Suppl., Abstract S043A-0974.

Pankow, K. L. and J. C. Pechmann (2004c). The SEA99 ground motion predictive relations for extensional tectonic regimes: Revisions and a new peak ground velocity relation, *Bull. Seism. Soc. Am.* **94**, 341-348.

Pankow, K. L. and J. C. Pechmann (2005). Determination of low-strain amplification factors in the Salt Lake Valley, Utah, using ANSS data, in *Proceedings of the Basin and Range Province Seismic Hazards Summit II*, W. R. Lund (Editor), *Utah Geol. Surv. Misc. Publ.*, in press.

Pankow, K. L., S. J. Nava, J. C. Pechmann, and W. J. Arabasz (2004). Triggered seismicity in Utah from the November 3, 2002, Denali fault earthquake, *Bull. Seism. Soc. Am.* **94** (6B), S332–S347.

Sheng, J., G. T. Schuster, K. L. Pankow, J. C. Pechmann, and R. L. Nowack (2003). Coherence-weighted wavepath migration of teleseismic data (abstract), *Eos, Trans. Am. Geophys. Union* **84** (46), Fall Meet. Suppl., Abstract S11E-0344.

UUSS Staff (2004). Earthquake activity in the Utah region [summaries and maps of seismicity in the Utah region, published quarterly by the Utah Division of Comprehensive Emergency Management in *Fault Line Forum*].

Velasco, A. A., C. J. Ammon, J. Farrell, and K. Pankow (2004). Rupture directivity of the 3 November 2002 Denali fault earthquake, *Bull. Seism. Soc. Am.* **94** (6B), S293–S299.

Wald, D. J., B. C. Worden, V. Quitoriano, and K. L. Pankow (2004). ShakeMap Manual: Users Guide, Technical Manual, and Software Guide, USGS Open File Report, in review, 131 pp.

TABLES AND FIGURES

Table 1

Overview of the University of Utah Regional/Urban Seismic Network
January 2005

Networks Forming Part of Regional Operation:	**CODE**	**Stations/channels**
∗ *Utah Region Seismic Network (URSN)*	*UU*	*142/377*
Yellowstone National Park Seismograph Network (YSN)	WY	23/34

TOTAL Stations/Channels Operated: 165/411

Import data from:	**CODE**	**Stations/channels**
Brigham Young University (Idaho) Seismic Network (formerly Ricks College)	RC	1/1
Montana Regional Seismic Network	MB	6/6
Idaho National Engineering and Environmental Laboratory Seismic Network	IE	7/7
Western Great Basin/Eastern Sierra Seismic Network University of Nevada, Reno	NN	6/6
US Bureau of Reclamation Seismic Networks	RE	2/2
US National Seismic Network	US	12/36
US National Strong Motion Program (via EW module getfile; triggered data from instruments in Wasatch Front area)	NP	Variable (.evt and xml files)
US National Strong Motion Program (direct data stream)	NP	4/12
Sandia National Laboratory—Leo Brady Network	LB	1/3
USGS Albuquerque Seismological Laboratory	IU	1/3
Northern Arizona University Seismic Network	AR	3/3
Total Stations/Channels Imported:		**43/79**

TOTAL Stations/Channels Recorded: 207/490

Export Data To:	**Stations/Channels**
Brigham Young University (Idaho) Seismic Network (formerly Ricks College)	22/30
Montana Regional Seismic Network	8/8
Idaho National Engineering and Environmental Laboratory Seismic Network	7/7
Northern Arizona University Seismic Network	2/2
US National Seismic Network	Export HYP, MAG, SMII messages
US National Seismic Network	20/48
IRIS Data Management Center (via ew2mseed)	185/433
Total Stations/Channels Exported:	**244/528**

(All real-time data exchange is via Earthworm Import/Export unless otherwise noted)

Table 2

Summary Statistics for UUSS Regional/Urban Seismic Network
(January 31, 2005)

Total no. of stations operated and/or recorded	207
Total no. of channels recorded	490
% Short-Period (SP) channels = 142/490	29.0%
% Broadband (BB) channels = 87/490	17.8%
% Strong-Motion (SM) channels* = 261/490	53.3%
*From both SM and BB/SM stations	
% SP stations = 102/207	49.3%
% BB stations = 31/207	15.0%
% SM stations = 74/207	35.7%
No. of stations in Wasatch Front Area	133
No. of channels in Wasatch Front Area	374
No. of stations in Utah Region	150
No. of channels in Utah Region	400
No. of stations in neighboring ISB (*mostly north of Utah*)	57
No. of channels in neighboring ISB (“ “ “ “)	90
No. of stations maintained & operated by UUSS	165
No. of UUSS stations sponsored by USGS	138
No. of UUSS stations maintained & operated as part of ANSS	76
No. of UUSS-recorded stations maintained by other institutions	43

Table 3. Earthquakes in the Utah Region of Magnitude 3.0 and Larger:

January 1, 2004 - January 31, 2005

DATE	ORIGIN TIME	LATITUDE	LONGITUDE	DEPTH	MAG	NO	GAP	DMN	RMS
041107	06:54:59.67	38º 14.72'	108º 54.67'	0.7	4.1W	12	189	6	0.17
040225	00:41:03.64	41º 59.82'	111º 49.08'	2.5*	3.4W	33	86	14	0.21
041218	17:38:58.22	37º 45.77'	113º 07.82'	5.5*	3.3W	10	84	27	0.26
040318	14:58:32.13	39º 39.26'	111º 56.38'	0.6*	3.3W	39	50	20	0.21
040313	13:04:47.38	39º 39.37'	111º 56.34'	2.1*	3.2W	40	50	20	0.24
040223	09:20:19.87	39º 12.73'	112º 02.05'	0.4*	3.0W	24	60	22	0.21
040604	08:41:46.77	42° 08.97'	111° 21.26'	6.3*	3.0W	22	138	24	0.23
040319	05:39:07.91	39º 39.15'	111º 56.51'	1.7*	3.0W	35	96	20	0.24
040319	14:23:28.10	39º 39.39'	111º 56.59'	2.7*	3.0W	27	97	20	0.23

number of earthquakes = 9

* indicates poor depth control
W indicates Wood-Anderson data used for magnitude calculation

Table 4

FELT EARTHQUAKES IN THE UTAH REGION
January 1, 2004 to January 31, 2005

Date	Time†	Felt Information‡	Latitude	Longitude	Magnitude§
Feb 12 (MST) Feb 13 (UTC)	23:35 MST 06:35 UTC	Utah. *CIIM*. Felt (IV) at Franklin, ID; (III) at Lewiston, UT, Cornish, UT, and Preston, ID; (II) at Richmond, UT. Also felt at Cove, UT.	41º 59.79'	111º 49.29'	M_L 2.8
Feb 16	11:02 MST 18:02 UTC	Idaho. Felt at Franklin (telephone report to UUSS).	42º 00.10'	111º 48.98'	M_L 2.0
Feb 23	02:20 MST 09:20 UTC	Utah. *CIIM**. Felt (II) at Fillmore and reportedly at Salt Lake City.	39º 12.73'	112º 02.05'	M_L 3.0
Feb 24 (MST) Feb 25 (UTC)	17:41 MST 00:41 UTC	Utah. *CIIM*. *ShakeMap*. Felt (IV) at Lewiston, UT, Franklin, ID, and Cornish, UT; (III) at Richmond, UT and Preston, ID.	41º 59.82'	111º 49.08'	M_L 3.4
March 11	14:16 MST 21:16 UTC	Utah. Felt at Franklin, ID (telephone report to UUSS).	41º 59.61'	111º 48.98'	M_L 2.0
March 13	06:04 MST 13:04 UTC	Utah. *CIIM**. Felt (II) at Nephi.	39º 39.37'	111º 56.34'	M_L 3.2
March 18	07:58 MST 14:58 UTC	Utah. *CIIM*. Felt (III) at Nephi. Also felt at Levan.	39º 39.26'	111º 56.38'	M_L 3.3
March 18	14:22 MST 21:22 UTC	Utah. *CIIM*. Felt (III) at Magna and Salt Lake City, (II) at Tooele.	40º 43.81'	112º 3.35'	M_L 2.4
March 18 (MST) March 19 (UTC)	22:39 MST 05:39 UTC	Utah. *CIIM*. Felt (III) at Nephi and (II) at Salt Lake City.	39º 39.15'	111º 56.51'	M_L 3.0
March 19	07:23 MST 14:23 UTC	Utah. *CIIM*. Felt (III) at Nephi.	39º 39.39'	111º 56.59'	M_L 3.0

Date	Time†	Felt Information‡	Latitude	Longitude	Magnitude§
June 04	02:41 MDT 08:41 UTC	Idaho. *CIIM*. Felt (III) at Paris.	42º 08.97'	111º 21.26'	M_L 3.0
June 08	08:56 MDT 14:56 UTC	Utah. *CIIM**. Felt (III) at Magna.	40º 43.56'	112º 04.22'	M_L 2.3
October 21	06:38 MDT 12:38 UTC	Idaho. *CIIM*. Felt (II) at Dayton.	42º 08.39'	112º 05.04'	M_L 2.9
November 06 November 07	23:54 MST 06:54 UTC	Colorado. *CIIM*. Felt (IV) at Bedrock; (II) at Denver.	38º 14.72'	108º 54.67'	M_L 4.1
November 12	08:15 MST 15:15 UTC	Utah. Felt at Salt Lake City (telephone report to UUSS).	40º 48.50'	111º 46.97'	M_L 2.1
November 12	14:20 MST 21:20 UTC	Utah. Felt at Salt Lake City (telephone report to UUSS).	40º 48.26'	111º 46.68'	M_L 2.0
December 18	10:38 MST 17:38 UTC	Utah. *CIIM*. Felt (III) at Cedar City.	37º 45.77'	113º 07.82'	M_L 3.3

† Times are listed both as Local Time—Mountain Standard Time (MST) or Mountain Daylight Time (MDT)—and as Universal Coordinated Time (UTC).

‡ *CIIM* indicates the availability of a Community Internet Intensity Map (*http://pasadena.wr.usgs.gov/shake/imw /archives.html*), compiled by the U.S. Geological Survey (USGS); *ShakeMap* indicates the availability of computer-generated maps of ground-shaking (*http://www.seis.utah.edu/shake/archive*), produced by the University of Utah Seismograph Stations (UUSS). Roman numerals correspond to the Modified Mercalli intensity scale. Unless otherwise indicated, felt information is from the USGS's (1) CIIM reports and/or (2) PDE Monthly (or) Weekly Listing Files (*http://neic.usgs.gov/neis /data_services/ ftp_files.html*).

* Original *CIIM* data for this event subsequently deleted from USGS Website because of small number of felt reports.

§ Richter local magnitude (M_L) or coda magnitude (M_C) determined by UUSS. If labeled “NEIS,” data are from the National Earthquake Information Service of the USGS.

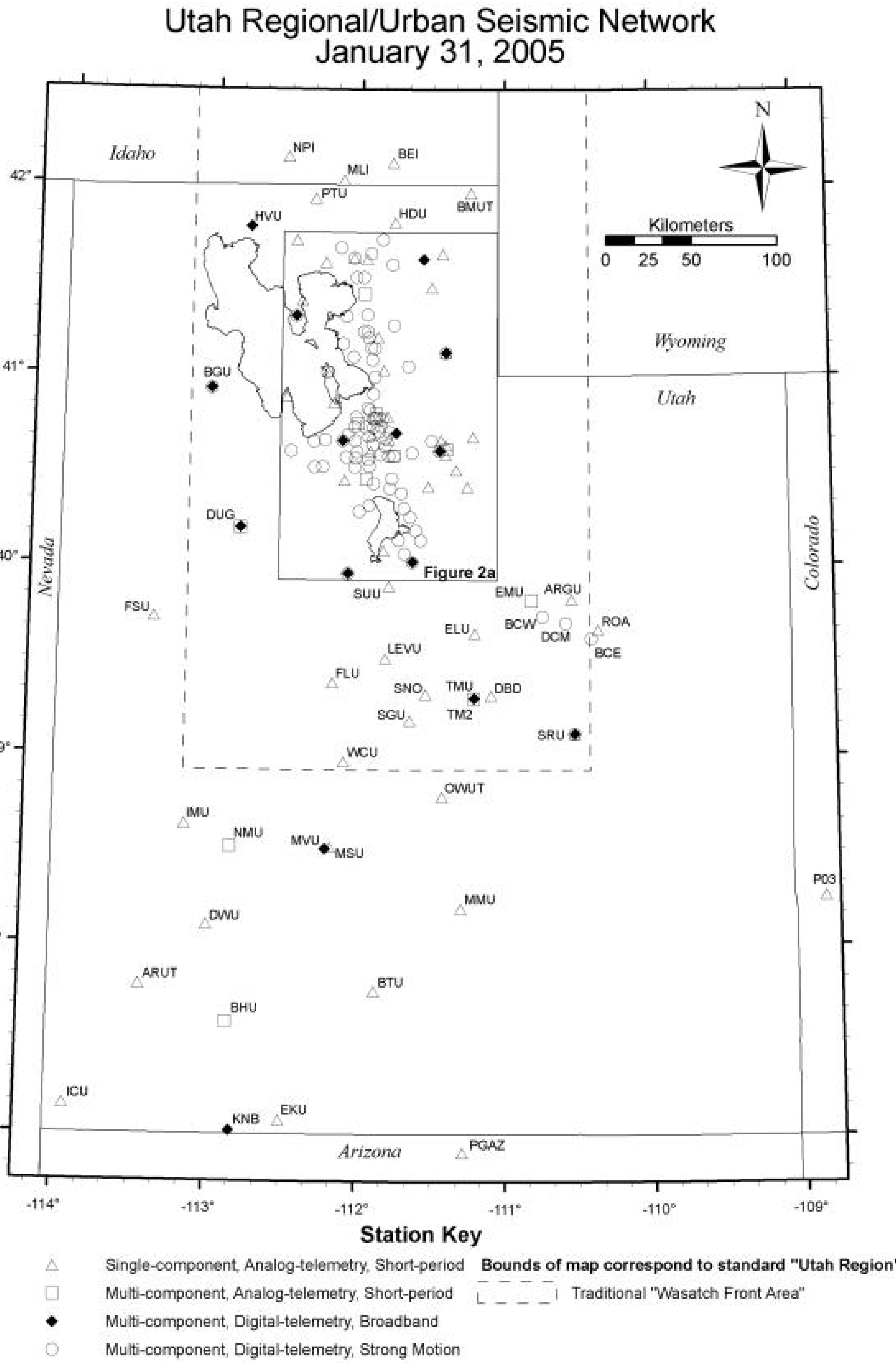
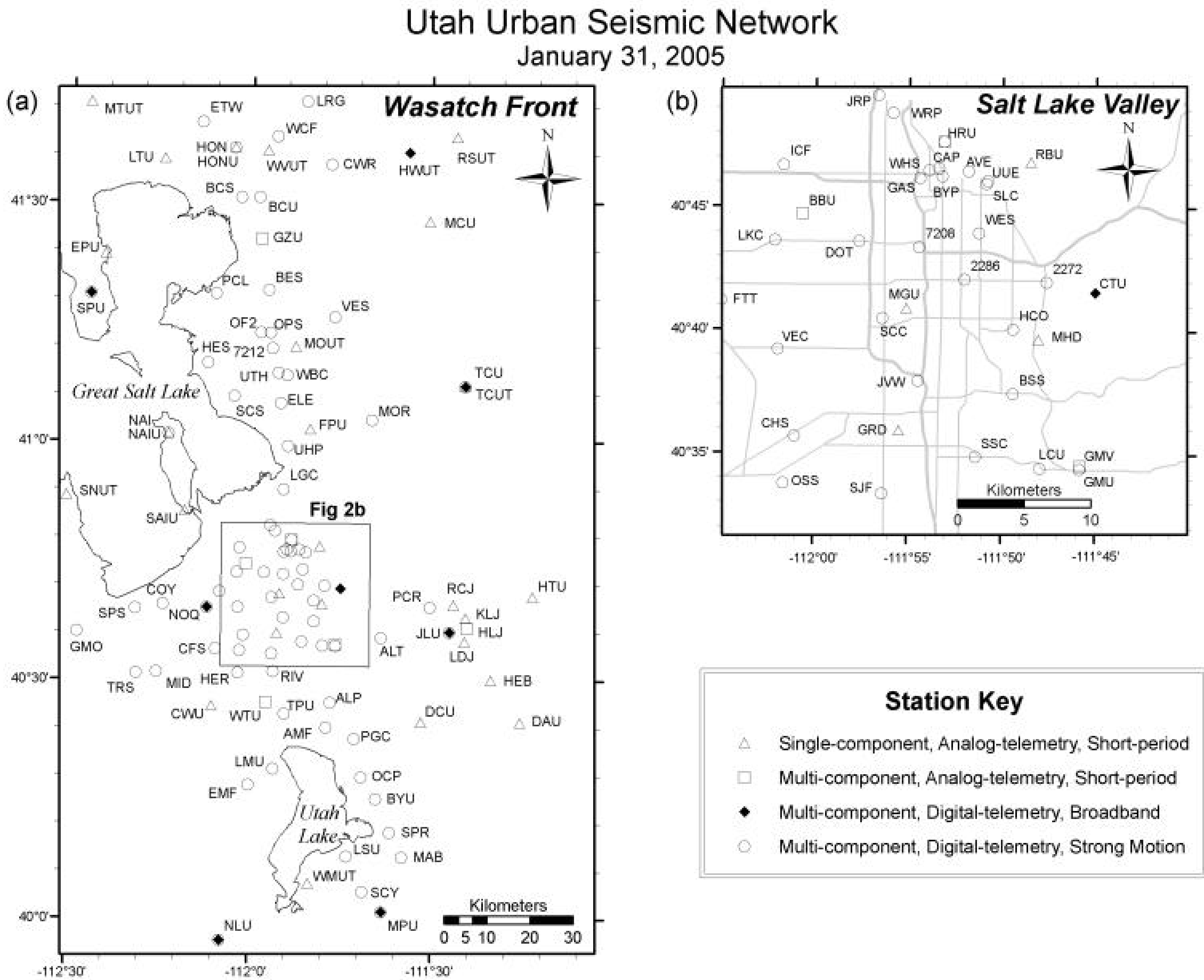

Utah Regional/Urban Seismic Network
January 31, 2005
Idaho
Wyoming
Utah
Nevada
Colorado
Arizona
N
Kilometers
0 25 50 100
Figure 2a
NPI
BEI
MLI
PTU
BMUT
HVU
HDU
BGU
DUG
FSU
SUU
EMU
ARGU
BCW
DCM
ROA
BCE
ELU
LEVU
FLU
SNO
TMU
DBD
SGU
TM2
SRU
WCU
OWUT
IMU
NMU
MVU
MSU
P03
MMU
DWU
ARUT
BTU
BHU
ICU
KNB
EKU
PGAZ
42°
41°
40°
39°
38°
37°
-114°
-113°
-112°
-111°
-110°
-109°
Station Key
Single-component, Analog-telemetry, Short-period
Multi-component, Analog-telemetry, Short-period
Multi-component, Digital-telemetry, Broadband
Multi-component, Digital-telemetry, Strong Motion
Bounds of map correspond to standard "Utah Region"
Traditional "Wasatch Front Area"

Figure 1



Utah Urban Seismic Network
January 31, 2005
(a)
Wasatch Front
Great Salt Lake
Utah Lake
Fig 2b
Kilometers
0 5 10 20 30
41°30'
41°0'
40°30'
40°0'
-112°30'
-112°0'
-111°30'
(b)
Salt Lake Valley
Kilometers
0 5 10
40°45'
40°40'
40°35'
-112°00'
-111°55'
-111°50'
-111°45'
Station Key
Single-component, Analog-telemetry, Short-period
Multi-component, Analog-telemetry, Short-period
Multi-component, Digital-telemetry, Broadband
Multi-component, Digital-telemetry, Strong Motion

Figure 2

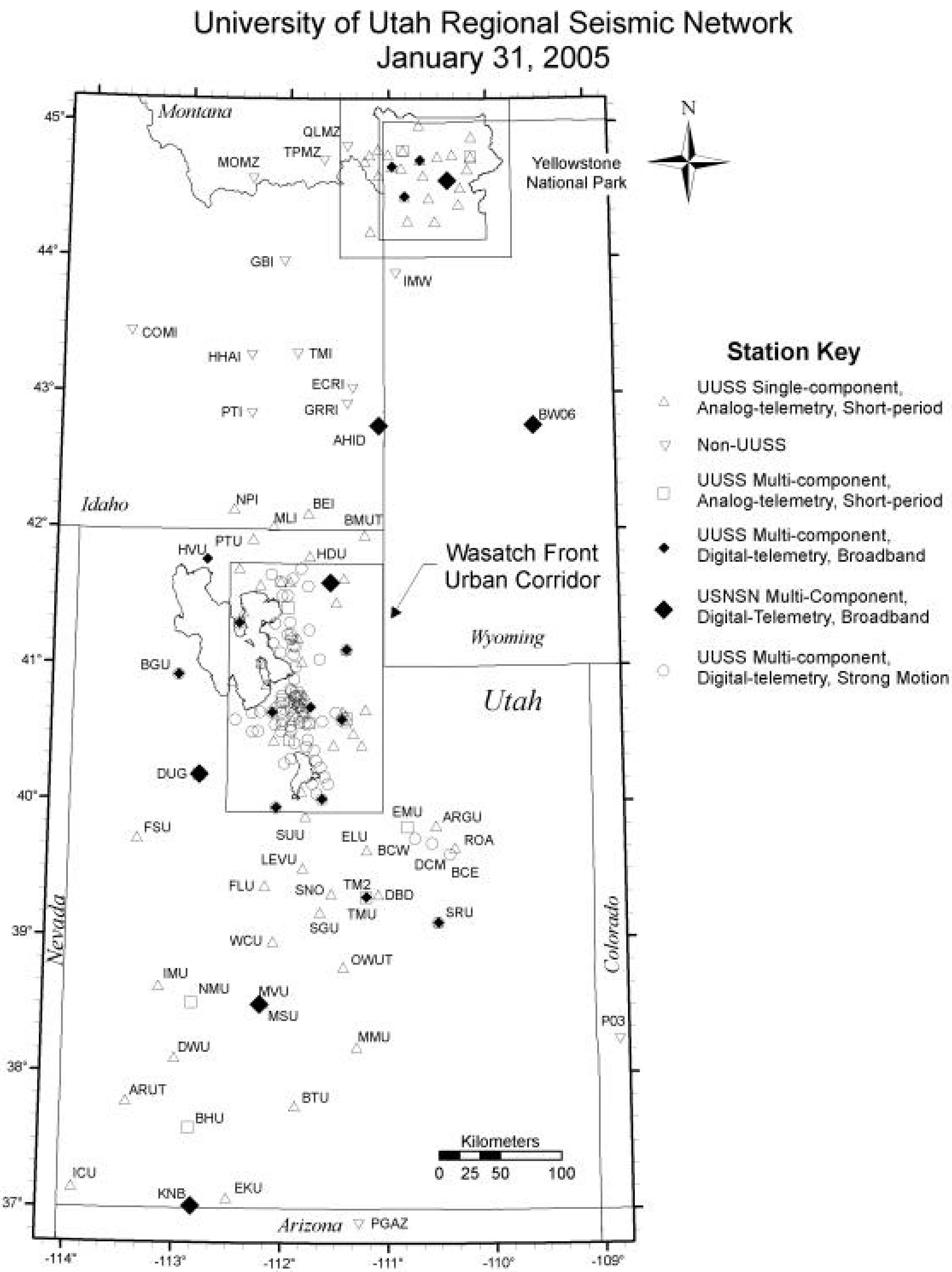

University of Utah Regional Seismic Network
January 31, 2005
Montana
Idaho
Wyoming
Utah
Nevada
Colorado
Arizona
Yellowstone National Park
Wasatch Front Urban Corridor
N
Station Key
UUSS Single-component, Analog-telemetry, Short-period
Non-UUSS
UUSS Multi-component, Analog-telemetry, Short-period
UUSS Multi-component, Digital-telemetry, Broadband
USNSN Multi-Component, Digital-Telemetry, Broadband
UUSS Multi-component, Digital-telemetry, Strong Motion
Kilometers
0 25 50 100
45°
44°
43°
42°
41°
40°
39°
38°
37°
-114°
-113°
-112°
-111°
-110°
-109°
QLMZ
TPMZ
MOMZ
GBI
IMW
COMI
HHAI
TMI
ECRI
PTI
GRRI
AHID
BW06
NPI
BEI
MLI
BMUT
PTU
HVU
HDU
BGU
DUG
FSU
EMU
ARGU
SUU
ELU
ROA
BCW
LEVU
DCM
BCE
FLU
SNO
TM2
DBD
TMU
SGU
SRU
WCU
OWUT
IMU
NMU
MVU
MSU
P03
MMU
DWU
ARUT
BTU
BHU
ICU
EKU
KNB
PGAZ

Figure 3

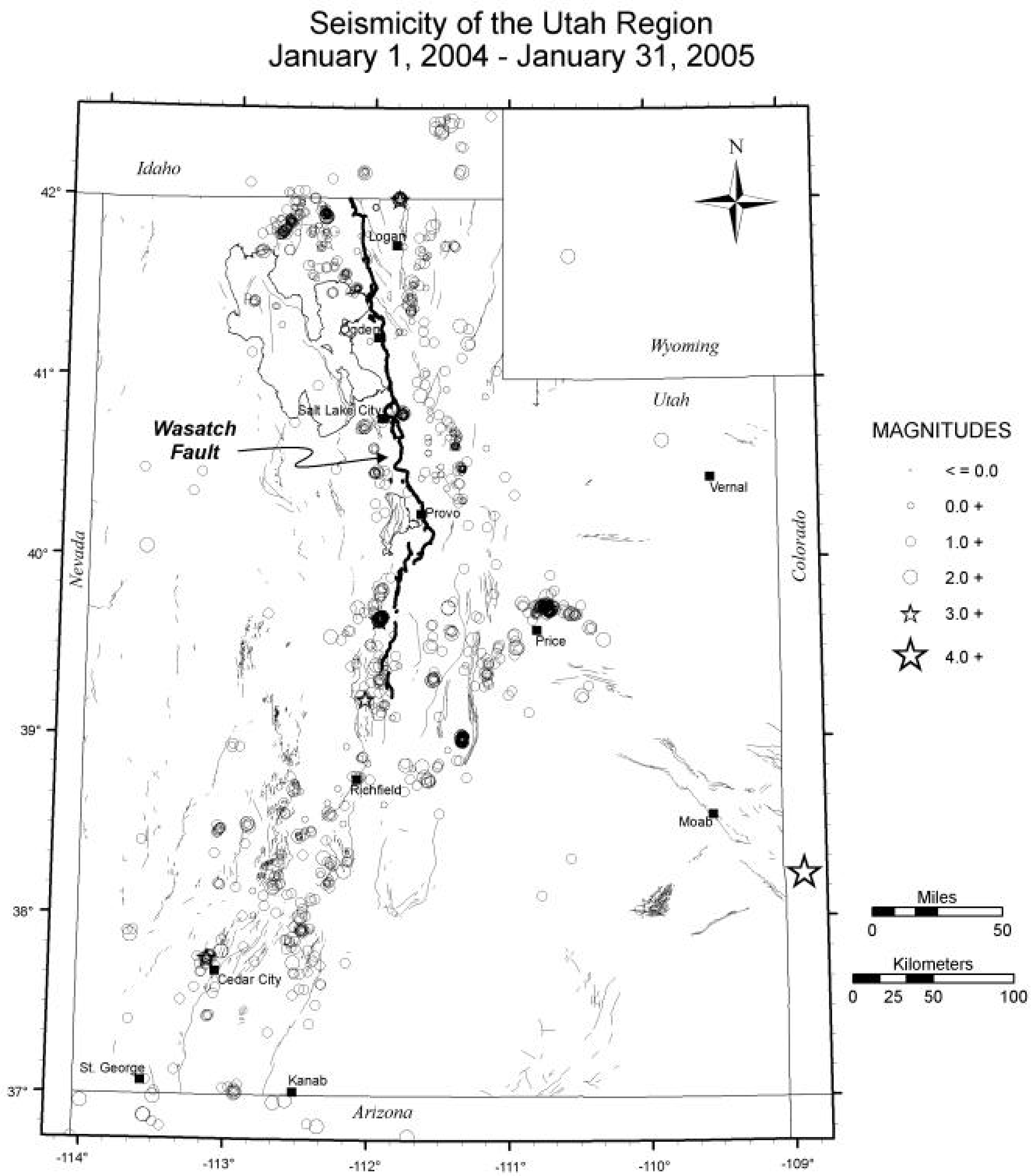


Figure 4. Earthquake epicenters (N=1,265) located by the University of Utah Seismograph Stations, superposed on a map of Quaternary (geologically young) faults compiled by the Utah Geological Survey. The Wasatch fault is shown in bold.

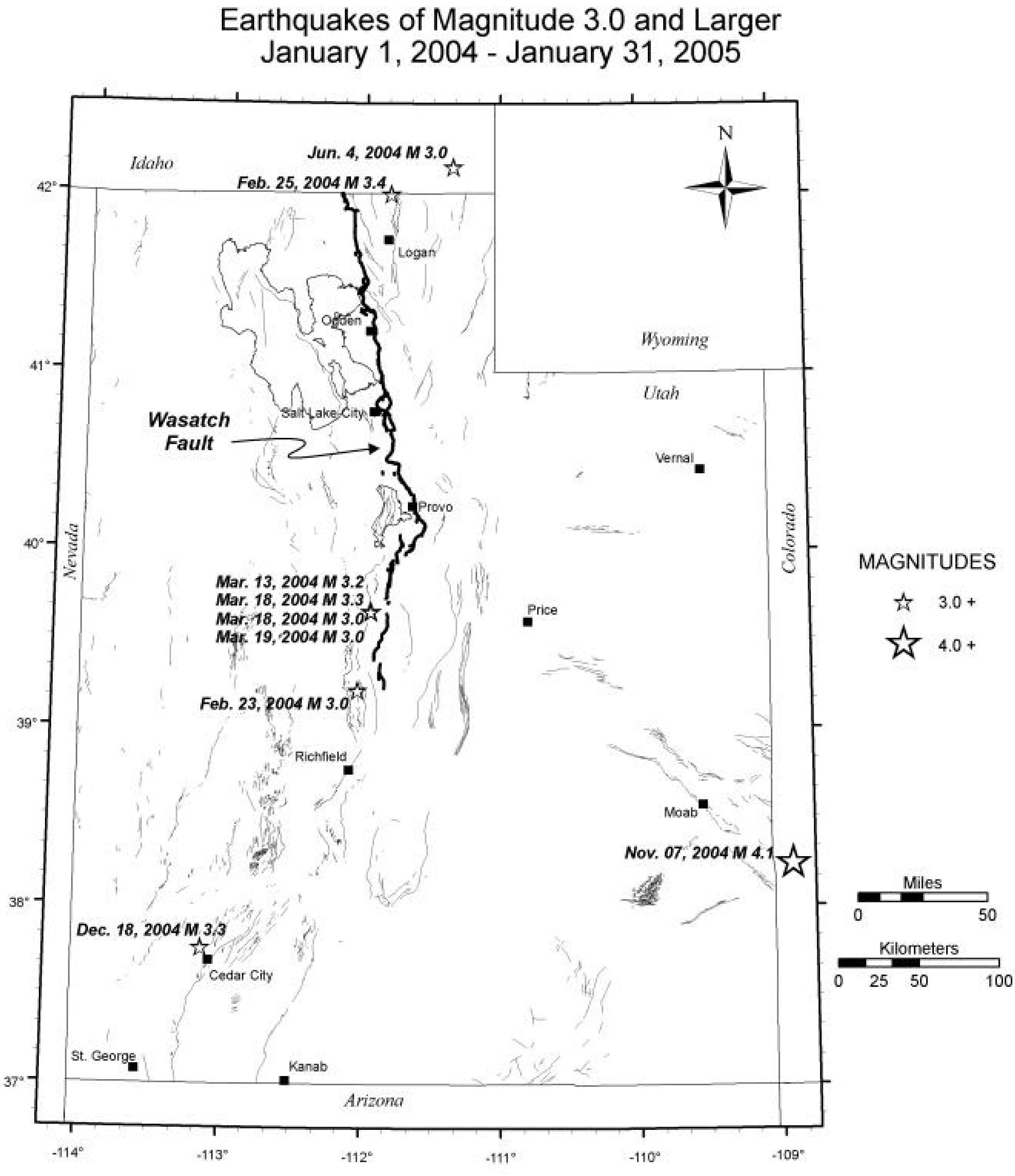


Figure 5. Epicenter map of shocks of magnitude 3.0 and larger in the Utah Region during the period January 1, 2004 – January 31, 2005 (basemap as in Figure 4). Epicenters, keyed to Table 1, are labeled by UTC date and size.

APPENDIX A

Station Information for University of Utah Regional/Urban Seismic Network
January 31, 2005

Table A-1
UNIVERSITY OF UTAH REGIONAL/URBAN SEISMIC NETWORK
Operating Seismograph Stations
January 31, 2005

UURSN Code	Location	SEED Station	SEED Channel	No. of Channels	Network Code	Latitude	Longitude	Elevation (meters)	Sensor	Digitizer	Telemetry	Sponsor
2272	Eastwood Elementary School Salt Lake City, UT	2272	HN[ZEN]	3	NP	40° 41.98'	111° 47.62'	1515	FBA23	Etna	Digital	NSMP
2286	Roosevelt Elementary School Salt Lake City, UT	2286	HN[ZEN]	3	NP	40° 42.08'	111° 52.01'	1314	EpiSensor	K2	Digital	NSMP
7208	SR 201/I-80 Bridge Array, Salt Lake City, UT	7208	EN[ZEN]	3	NP	40° 43.38'	111° 54.43'	1291	EpiSensor	K2	Digital	NSMP
7212	Annex Bldg., Weber State University, Ogden, UT	7212	HN[ZEN]	3	NP	41° 11.75'	111° 56.50'	1422	EpiSensor	K2	Digital	NSMP
AHI	Auburn, ID	AHID	BH[ZEN]	3	US	42° 45.92'	111° 06.02'	1960	*	*	Digital	USGS
ALP	Alpine Fire Station, Alpine, UT	ALP	EN[ZEN]	3	UU	40° 27.26'	111° 46.61'	1510	EpiSensor	K2	Digital	ANSS
ALT	Alta City Offices, Alta, UT	ALT	EN[ZEN]	3	UU	40° 35.42'	111° 38.25'	2635	Applied Mems	ANSS-130	Digital	ANSS
AMF	Tri-Cities Golf Course American Fork, UT	AMF	EN[ZEN]	3	UU	40° 24.11'	111° 47.27'	1445	EpiSensor	K2	Digital	ANSS
ANMO	Albuquerque, NM	ANMO	BH[ZEN]	3	IU	39° 56.77'	106° 27.40'	1740	*	*	Digital	USGS
ARGU	*Argyle Ridge, UT*	*ARGU*	*EHZ*	*1*	*UU*	*39° 49.37'*	*110° 32.62'*	*2828*	*S13*	*Masscomp*	*Analog*	*Utah*
ARUT	Antelope Range, UT	ARUT	EHZ	1	UU	37° 47.28'	113° 26.42'	1646	L4C	Masscomp	Analog	Utah
AVE	Avenues, Salt Lake City, UT	AVE	EN[ZEN]	3	UU	40° 46.47'	111° 51.83'	1387	Applied Mems	ANSS-130	Digital	ANSS
BBU	Bumble Bee, Salt Lake City, UT	BBU	EH[ZEN]	3	UU	40° 44.73'	112° 00.67'	1291	L4C	Masscomp	Analog	USGS
BCE	Book Cliffs East, UT	BCE	EHZ EN[ZEN]	4	UU	39° 36.79'	110° 24.51'	2666	L4C EpiSensor	K2	Digital	ANSS
BCS	Brigham City Maintenance Shop Brigham City, UT	BCS	EN[ZEN]	3	UU	41° 30.71'	112° 01.98'	1303	EpiSensor	K2	Digital	ANSS
BCU	Brigham City, UT	BCU	EN[ZEN]	3	UU	41° 30.74'	111° 58.93'	1676	EpiSensor	K2	Digital	ANSS
BCW	Book Cliffs West, UT	BCW	EHZ EN[ZEN]	4	UU	39° 43.82'	110° 44.55'	2614	L4C EpiSensor	K2	Digital	ANSS
BEI	Bear River Range, ID	BEI	EHZ	1	UU	42° 07.00'	111° 46.94'	1859	L4C	Masscomp	Analog	USGS
BES	Bates Elementary School Ogden, UT	BES	EN[ZEN]	3	UU	41° 19.10'	111° 57.26'	1455	EpiSensor	K2	Digital	ANSS
BGMZ	Barton Gulch, MT	BGMT	EHZ	1	MB	45° 14.00'	112° 02.43'	2172	*	*	Analog	MBMT

UURSN Code	Location	SEED Station	SEED Channel	No. of Channels	Network Code	Latitude	Longitude	Elevation (meters)	Sensor	Digitizer	Telemetry	Sponsor
BGU	Big Grassy Mountain, UT	BGU	EN[ZEN] HH[ZEN]	3 3	UU	40° 55.53'	113° 01.79'	1640	EpiSensor 3ESP	72A-08	Digital	ANSS
BHU	Blowhard Mountain, UT	BHU	EH[ZEN]	3	UU	37° 35.55'	112° 51.42'	3230	S13	Masscomp	Analog	Utah
BMN	Battle Mountain, NM	BMN	BHZ	1	NN	40° 25.89'	117° 13.31'	1594	*	*	Digital	UNR
BMUT	Black Mountain, UT	BMUT	EHZ	1	UU	41° 57.49'	111° 14.05'	2243	S13	Masscomp	Analog	USGS
BON	Boundary Peak, NV	BONR	SHZ	1	NN	37° 57.31'	118° 18.10'	2582	*	*	Digital	UNR
BOZ	Bozeman, MT	BOZ	BH[ZEN]	3	US	45° 38.82'	111° 37.78'	1589	*	*	Digital	USGS
BSS	Butlerville Substation Salt Lake City, UT	BSS	EN[ZEN]	3	UU	40° 37.45'	111° 49.37'	1411	EpiSensor	K2	Digital	ANSS
BTU	Barney Top, UT	BTU	EHZ	1	UU	37° 45.34'	111° 52.46'	3235	S13	Masscomp	Analog	Utah
BW0	Boulder, WY	BW06	BH[ZEN]	3	US	42° 46.00'	109° 33.50'	2224	*	*	Digital	USGS
BYP	Brigham Young Park Salt Lake City, UT	BYP	EN[ZEN]	3	UU	40° 46.26'	111° 53.23'	1323	Applied Mems	ANSS-130	Digital	ANSS
BYU	Brigham Young University Provo, UT	BYU	EN[ZEN]	3	UU	40° 15.17'	111° 38.97'	1421	EpiSensor	K2	Digital	ANSS
BZMZ	Bozeman Pass, MT	BZMT	EHZ	1	MB	45° 38.89'	110° 47.80'	1905	*	*	Analog	MBMT
CAP †	*Capitol, Salt Lake City, UT*	*CAP*	*EN[ZEN]*	*3*	*UU*	*40° 46.71'*	*111° 53.40'*	*1384*	*Applied Mems*	*ANSS-130*	*None*	*ANSS*
CFS	Copperton Fire Station Copperton, UT	CFS	EN[ZEN]	3	UU	40° 33.96'	112° 05.61'	1654	EpiSensor	K2	Digital	ANSS
CHS	Copper Hills High School, West Jordan, UT	CHS	EN[ZEN]	3	UU	40° 35.68'	112° 01.03'	1460	Applied Mems	ANSS-130	Digital	ANSS
COM	Craters of the Moon, ID	COMI	EHZ	1	IE	43° 27.72'	113° 35.64'	1890	*	*	Digital	INEEL
COY	Coyote Canyon, Tooele Valley, UT	COY	EN[ZEN]	3	UU	40° 39.56'	112° 14.34'	1572	Applied Mems	ANSS-130	Digital	ANSS
CRMZ	*Chrome Mountain, MT*	*CRMT*	*EHZ*	*1*	*MB*	*45° 27.35'*	*110° 08.41'*	*2941*	*	*	*Analog*	*MBMT*
CTU	Camp Tracy, UT	CTU	HH[ZEN]	3	UU	40° 41.55'	111° 45.02'	1731	40T	72A-07	Digital	USGS
CWR	Coldwater Ranch, Paradise, UT	CWR	EN[ZEN]	3	UU	41° 34.90'	111° 46.89'	1837	Applied Mems	ANSS-130	Digital	ANSS
CWU	Camp Williams, UT	CWU	EHZ	1	UU	40° 26.75'	112° 06.13'	1945	L4C	Masscomp	Analog	USGS
DAU	Daniels Canyon, UT	DAU	EHZ	1	UU	40° 24.75'	111° 15.35'	2771	S13	Masscomp	Analog	USGS
DBD	Des Bee Dove, UT	DBD	EHZ	1	UU	39° 18.82'	111° 05.55'	2265	L4C	Masscomp	Analog	Utah
DCM	Dugout Coal Mine, UT	DCM	EHZ EN[ZEN]	1 3	UU	39° 41.70'	110° 35.00'	2537	L4C EpiSensor	K2	Digital	Utah
DCU	Deer Creek Reservoir, UT	DCU	EHZ	1	UU	40° 24.82'	111° 31.61'	1829	L4C	Masscomp	Analog	USGS

UURSN Code	Location	SEED Station	SEED Channel	No. of Channels	Network Code	Latitude	Longitude	Elevation (meters)	Sensor	Digitizer	Telemetry	Sponsor
DOT	Utah Dept. of Transportation Region II Offices, Salt Lake City, UT	DOT	EN[ZEN]	3	UU	40° 43.61'	111° 57.65'	1282	Applied Mems	ANSS-130	Digital	ANSS
DUG	Dugway, UT	DUG	BH[ZEN]	3	US	40° 11.70'	112° 48.80'	1477	*	*	Digital	USGS
			EH[ZEN] EL[ZEN]	6	UU				S13	Masscomp	Analog	Utah, USGS
DWU	Dry Willow, UT	DWU	EHZ	1	UU	38° 06.32'	112° 59.85'	2270	S13	Masscomp	Analog	Utah
ECR	Eagle Creek, ID	ECRI	EHZ	1	IE	43° 03.24'	111° 22.26'	2086	*	*	Digital	INEEL
EKU	East Kanab, UT	EKU	EHZ	1	UU	37° 04.48'	112° 29.81'	1829	S13	Masscomp	Analog	Utah
ELE	East Layton Elementary School, East Layton, UT	ELE	EN[ZEN]	3	UU	41° 04.84'	111° 55.09'	1444	Applied Mems	ANSS-130	Digital	ANSS
ELK	Elko, NV	ELK	BH[ZEN]	3	US	40° 44.69'	115° 14.33'	2210	*	*	Digital	USGS
ELU	Electric Lake, UT	ELU	EHZ	1	UU	39° 38.41'	111° 12.23'	2970	L4C	Masscomp	Analog	Utah
EMF	Eagle Mountain Gas Tap, UT	EMF	EN[ZEN]	3	UU	40° 16.89'	111° 59.92'	1487	Applied Mems	ANSS-130	Digital	ANSS
EMU	Emma Park, UT	EMU	EH[ZEN] ELZ	4	UU	39° 48.84'	110° 48.92'	2268	S13	Masscomp	Analog	USGS
			EN[ZEN]	3					FBA23	K2	None	Utah
EPU	East Promontory, UT	EPU	EHZ	1	UU	41° 23.49'	112° 24.53'	1436	L4C	Masscomp	Analog	USGS
ETW	Elwood Town Hall, Elwood, UT	ETW	EN[ZEN]	3	UU	41° 40.15'	112° 08.53'	1305	Applied Mems	ANSS-130	Digital	ANSS
FLU	Fool's Peak, UT	FLU	EHZ	1	UU	39° 22.69'	112° 10.29'	1951	18300	Masscomp	Analog	USGS
FPU	Francis Peak, UT	FPU	EHZ	1	UU	41° 01.58'	111° 50.21'	2816	L4C	Masscomp	Analog	USGS
FSU	Fish Springs, UT	FSU	EHZ	1	UU	39° 43.35'	113° 23.48'	1487	18300	Masscomp	Analog	Utah
FTT	Fire Training Tower, Magna, UT	FTT	EN[ZEN]	3	UU	40° 41.16'	112° 04.99'	1381	Applied Mems	ANSS-130	Digital	ANSS
GAS	PacifiCorp Gasification Plant, Salt Lake City, UT	GAS	EN[ZEN]	3	UU	40° 46.18'	111° 54.41'	1294	Applied Mems	ANSS-130	Digital	ANSS
GBI	Big Grassy Butte, ID	GBI	EHZ	1	IE	43° 59.22'	112° 03.78'	1541	*	*	Digital	INEEL
GCN	Grand Canyon, AZ	GCN	EHZ	1	AR	36° 02.64'	112° 07.68'	2294	*	*	Analog	NAU
GMO	Grantsville Maintenance Office, Grantsville, UT	GMO	EN[ZEN]	3	UU	40° 36.04'	112° 28.48'	1320	Applied Mems	ANSS-130	Digital	ANSS
GMU	Granite Mountain, UT	GMU	EH[ZEN] ELZ	4	UU	40° 34.53'	111° 45.79'	1829	S13	Masscomp	Analog	USGS
GMV	Granite Mountain Vault Sandy, UT	GMV	EN[ZEN]	3	UU	40° 34.40'	111° 45.79'	1829	EpiSensor	K2	Digital	ANSS

UURSN Code	Location	SEED Station	SEED Channel	No. of Channels	Network Code	Latitude	Longitude	Elevation (meters)	Sensor	Digitizer	Telemetry	Sponsor
GRD	Gardner Farm, UT	GRD	EHZ	1	UU	40° 35.93'	111° 55.47'	1323	Ranger	Masscomp	Analog	USGS
GRR	Grays Lake, ID	GRRI	EHZ	1	IE	42° 56.28'	111° 25.32'	2207	*	*	Digital	INEEL
GZU	Grizzly Peak, UT	GZU	EH[ZEN]	4	UU	41° 25.53'	111° 58.50'	2646	S13	Masscomp	Analog	USGS
			ELZ									
HCO	Holladay City Offices Holladay, UT	HCO	EN[ZEN]	3	UU	40° 40.07'	111° 49.38'	1362	EpiSensor	K2	Digital	ANSS
HDU	Hyde Park, UT	HDU	EHZ	1	UU	41° 48.18'	111° 45.99'	1807	L4C	Masscomp	Analog	USGS
HEB	*Heber, UT*	*HEB*	*EHZ*	*1*	*UU*	*40° 30.09'*	*111° 20.15'*	*1925*	*S13*	*Masscomp*	*Analog*	*Utah*
HER	Herriman Fire Station Herriman, UT	HER	EN[ZEN]	3	UU	40° 30.94'	112° 01.85'	1502	EpiSensor	K2	Digital	ANSS
HES	Hooper Elementary School Hooper, UT	HES	EN[ZEN]	3	UU	41° 09.89'	112° 07.30'	1292	EpiSensor	K2	Digital	ANSS
HHA	Hell's Half Acre, ID	HHAI	EHZ	1	IE	43° 17.70'	112° 22.74'	1371	*	*	Digital	INEEL
HLI	Hailey, ID	HLID	BH[ZEN]	3	US	43° 33.75'	114° 24.83'	1772	*	*	Digital	USGS
HLJ	Hailstone, UT	HLJ	EHZ	1	UU	40° 36.64'	111° 24.05'	1931	S13	Masscomp	Analog	Utah
			EN[ZEN]	3					FBA23	K2	None	
HON	Honeyville, UT	HON	EN[ZEN]	3	UU	41° 36.97'	112° 03.05'	1528	Applied Mems	ANSS-130	Digital	ANSS
HONU		HONU	EHZ	1					L4C	Masscomp	Analog	USGS
HRU	Hogsback Ridge, UT	HRU	EHZ	1	UU	40° 47.67'	111° 53.14'	1620	Ranger	Masscomp	Analog	USGS
			EN[ZEN]	3					Applied Mems	ANSS-130	Digital	ANSS
HTU	Hoyt, UT	HTU	EHZ	1	UU	40° 40.52'	111° 13.21'	2576	L4C	Masscomp	Analog	USGS
HVU	Hansel Valley, UT	HVU	HH[ZEN]	3	UU	41° 46.78'	112° 46.50'	1609	40T	72A-07	Digital	USGS
HWU	Hardware Ranch, UT	HWUT	BH[ZEN]	3	US	41° 36.41'	111° 33.91'	1830	*	*	Digital	USGS
ICF	International Center Fire Station, Salt Lake City, UT	ICF	EN[ZEN]	3	UU	40° 46.69'	112° 01.72'	1281	EpiSensor	K2	Digital	ANSS
ICU	Indian Springs Canyon, UT	ICU	EHZ	1	UU	37° 08.98'	113° 55.41'	1451	S13	Masscomp	Analog	Utah
IMU	Iron Mountain, UT	IMU	EHZ	1	UU	38° 37.99'	113° 09.50'	1833	L4C	Masscomp	Analog	Utah
IMW	Indian Meadows, WY	IMW	EHZ	1	RC	43° 53.82'	110° 56.34'	2646	*	*	Analog	BYU-I
JLU	Jordanelle, UT	JLU	EN[ZEN]	3	UU	40° 36.12'	111° 27.00'	2285	EpiSensor	72A-08	Digital	ANSS
			HH[ZEN]	3					3ESP			
JRP	Jordan River State Park Salt Lake City, UT	JRP	EN[ZEN]	3	UU	40° 49.54'	111° 56.66'	1284	EpiSensor	K2	Digital	ANSS
JVW	Jordan Valley Water District Well, Murray, UT	JVW	EN[ZEN]	3	UU	40° 37.95'	111° 54.46'	1315	Applied Mems	ANSS-130	Digital	ANSS
KLJ	Keetley, UT	KLJ	EHZ	1	UU	40° 37.85'	111° 24.30'	1992	S13	Masscomp	Analog	Utah

UURSN Code	Location	SEED Station	SEED Channel	No. of Channels	Network Code	Latitude	Longitude	Elevation (meters)	Sensor	Digitizer	Telemetry	Sponsor
KNB	Kanab, UT	KNB	BH[ZEN]	3	US	37° 01.00'	112° 49.34'	1715	*	*	Digital	LLNL
LCU	*Little Cottonwood, UT*	*LCU*	*EN[ZEN]*	*3*	*UU*	*40° 34.41'*	*111° 47.91'*	*1571*	*Applied* Mems	*K2*	*Digital*	*ANSS*
LDJ	Lady, UT	LDJ	EHZ	1	UU	40° 34.89'	111° 24.52'	2217	S13	Masscomp	Analog	Utah
LEVU	Levan, UT	LEVU	EHZ	1	UU	39° 30.39'	111° 48.88'	1996	L4C	Masscomp	Analog	USGS
LGC	Lakeside Golf Course Bountiful, UT	LGC	EN[ZEN]	3	UU	40° 54.04'	111° 54.51'	1292	EpiSensor	K2	Digital	ANSS
LKC	Lee Kay Hunter Education Center Magna, UT	LKC	EN[ZEN]	3	UU	40° 43.62'	112° 02.14'	1289	EpiSensor	K2	Digital	ANSS
LKW	Lake, WY	LKWY	BH[ZEN]	3	US	44° 33.91'	110° 24.00'	2424	*	*	Digital	USGS
LMU	Lake Mountain, UT	LMU	EN[ZEN]	3	UU	40° 18.91'	111° 55.92'	1593	EpiSensor	K2	Digital	ANSS
LRG	Logan River Golf Course Logan, UT	LRG	EN[ZEN]	3	UU	41° 42.82'	111° 51.08'	1362	Applied Mems	ANSS-130	Digital	ANSS
LSU	Lake Shores, UT	LSU	EN[ZEN]	3	UU	40° 07.94'	111° 43.80'	1375	EpiSensor	K2	Digital	ANSS
LTU	Little Mountain, UT	LTU	EHZ	1	UU	41° 35.51'	112° 14.83'	1585	L4C	Masscomp	Analog	USGS
MAB	Mapleton Ambulance Building Mapleton, UT	MAB	EN[ZEN]	3	UU	40° 07.85'	111° 34.67'	1440	EpiSensor	K2	Digital	ANSS
MCID	Moose Creek, ID	MCID	EHZ	1	WY	44° 11.45'	111° 11.03'	2137	L4C	Masscomp	Analog	USGS
MCU	Monte Cristo Peak, UT	MCU	EHZ	1	UU	41° 27.70'	111° 30.45'	2664	18300	Masscomp	Analog	USGS
MGU	Meadow Brook Golf Course Salt Lake City, UT	MGU	EHZ	1	UU	40° 40.89'	111° 55.09'	1291	Ranger	Masscomp	Analog	USGS
MHD	Mile High Drive, UT	MHD	EHZ	1	UU	40° 39.64'	111° 48.05'	1597	Ranger	Masscomp	Analog	USGS
MID	Middle Canyon, UT	MID	EN[ZEN]	3	UU	40° 31.04'	112° 15.28'	1722	Applied Mems	ANSS-130	Digital	ANSS
MLI	Malad Range, ID	MLI	EHZ	1	UU	42° 01.61'	112° 07.53'	1896	L4C	Masscomp	Analog	USGS
MMU	Miners Mountain, UT	MMU	EHZ	1	UU	38° 11.57'	111° 17.66'	2387	S13	Masscomp	Analog	Utah
MOMZ	Monida, MT	MOMT	EHZ	1	MB	44° 35.60'	112° 23.66'	2220	*	*	Analog	MBMT
MOR	*Morgan,UT*	*MOR*	*EN[ZEN]*	*3*	*UU*	*41° 02.77'*	*111° 39.94'*	*1633*	*Applied Mems*	*ANSS-130*	*Digital*	*ANSS*
MOUT	Mount Ogden, UT	MOUT	EHZ	1	UU	41° 11.94'	111° 52.73'	2743	S13	Masscomp	Analog	USGS
MPU	Maple Canyon, UT	MPU	EN[ZEN]	3	UU	40° 00.93'	111° 38.00'	1909	EpiSensor	K2	Digital	ANSS
			HH[ZEN]	3					40T	72A-07	Digital	USGS
MSU	Marysvale, UT	MSU	EHZ	1	UU	38° 30.74'	112° 10.63'	2105	18300	Masscomp	Analog	Utah
MTLO	Mt. Logan, AZ	MTL	EHZ	1	AR	36° 21.18'	113° 11.94'	2418	*	*	Analog	NAU
MTUT	Morton Thiokol, UT	MTUT	EHZ	1	UU	41° 42.55	112° 27.28'	1373	L4C	Masscomp	Analog	USGS
MVU	Marysvale, UT	MVU	BH[ZEN]	3	LB	38° 30.22'	112° 12.74'	2240	*	*	Digital	Sandia

UURSN Code	Location	SEED Station	SEED Channel	No. of Channels	Network Code	Latitude	Longitude	Elevation (meters)	Sensor	Digitizer	Telemetry	Sponsor
NAI	North Antelope Island, UT	NAI	EN[ZEN]	3	UU	41° 00.97'	112° 13.68'	1472	EpiSensor	K2	Digital	ANSS
NAIU		NAIU	EHZ	1					L4C	Masscomp	Analog	USGS
NLU	North Lily Mine, UT	NLU	EN[ZEN]	3	UU	39° 57.29'	112° 04.50'	2036	Episensor	72A-08	Digital	ANSS
			HH[ZEN]	3					3ESP			
NMU	North Mineral Mountain, UT	NMU	EH[ZEN]	4	UU	38° 30.99'	112° 51.00'	1853	S13	Masscomp	Analog	Utah
			ELZ									
NOQ	North Oquirrh Mountains, UT	NOQ	EN[ZEN]	3	UU	40° 39.17'	112° 07.13'	1622	EpiSensor	K2	Digital	ANSS
			HH[ZEN]	3					40T	72A-07	Digital	USGS
NPI	North Pocatello, ID	NPI	EHZ	1	UU	42° 08.84'	112° 31.10'	1640	L4C	Masscomp	Analog	USGS
OCP	Orem City Park, Orem, UT	OCP	EN[ZEN]	3	UU	40° 17.87'	111° 41.44'	1464	EpiSensor	K2	Digital	ANSS
OF2	Ogden Fire Station º 2 Ogden, UT	OF2	EN[ZEN]	3	UU	41° 13.70'	111° 56.92'	1358	EpiSensor	K2	Digital	ANSS
OPS	*Ogden Public Safety Building, Ogden, UT*	*OPS*	*EN[ZEN]*	*3*	*UU*	*41° 13.72'*	*111° 58.54'*	*1317*	*Applied Mems*	*ANSS-130*	*Digital*	*ANSS*
OSS	Oquirrh Sub Station, UT	OSS	EN[ZEN]	3	UU	40° 33.77'	112° 01.61'	1503	Applied Mems	ANSS-130	Digital	ANSS
OWUT	Old Woman Plateau, UT	OWUT	EHZ	1	UU	38° 46.80'	111° 25.42'	2568	L4C	Masscomp	Analog	Utah
P03	Wild Steer, Paradox Basin, CO	PV03	EHZ	1	RE	38° 15.26'	108° 50.88'	1975	*	*	Analog	USBR
P15	Potato Mountain Paradox Basin, CO	PV15	EHZ	1	RE	38° 20.51'	108° 28.86'	2280	*	*	Analog	USBR
PCL	Plain City Landfill Plain City, UT	PCL	EN[ZEN]	3	UU	41° 18.60'	112° 06.00'	1290	Applied Mems	ANSS-130	Digital	ANSS
PCR	Park City Recreation Center Park City, UT	PCR	EN[ZEN]	3	UU	40° 39.25'	111° 30.19'	2100	EpiSensor	K2	Digital	ANSS
PGAZ	Page, AZ	PGA	EHZ	1	AR	36° 54.34'	111° 16.86'	1272	*	*	Analog	NAU
PGC	Pleasant Grove Creek, UT	PGC	EN[ZEN]	3	UU	40° 22.71'	111° 42.62'	1707	EpiSensor	K2	Digital	ANSS
PRN	Pahroc, Range, NV	PRN	SHZ	1	NN	37° 24.40'	115° 03.05'	1402	*	*	Digital	UNR
PTI	Pocatello, ID	PTI	EHZ	1	IE	42° 52.20'	112° 22.21'	1670	*	*	Digital	INEEL
PTU	Portage, UT	PTU	EHZ	1	UU	41° 55.76'	112° 19.48'	2192	L4C	Masscomp	Analog	USGS
QLMZ	Earthquake Lake, MT	QLMT	EHZ	1	MB	44° 49.84'	111° 25.80'	2064	*	*	Analog	MBMT
RBU	Red Butte Canyon, UT	RBU	EHZ	1	UU	40° 46.85'	111° 48.50'	1676	L4C	Masscomp	Analog	USGS
RCJ	Ross Creek, UT	RCJ	EHZ	1	UU	40° 39.51'	111° 26.36'	2090	S13	Masscomp	Analog	Utah
RIV	Public Works Building Riverton, UT	RIV	EN[ZEN]	3	UU	40° 31.16'	111° 56.05'	1347	EpiSensor	K2	Digital	ANSS
ROA	*Roan Cliffs, UT*	*ROA*	*EHZ*	*1*	*UU*	*39° 39.69'*	*110° 21.88'*	*2962*	*S13*	*Masscomp*	*Analog*	*USGS*
RSUT	Red Spur, UT	RSUT	EHZ	1	UU	41° 38.31'	111° 25.90'	2682	S13	Masscomp	Analog	USGS

UURSN Code	Location	SEED Station	SEED Channel	No. of Channels	Network Code	Latitude	Longitude	Elevation (meters)	Sensor	Digitizer	Telemetry	Sponsor
SAIU	South Antelope Island, UT	SAIU	EHZ	1	UU	40° 51.29'	112° 10.89'	1384	L4C	Masscomp	Analog	USGS
SCC	Salt Lake Community College Salt Lake City, UT	SCC	EN[ZEN]	3	UU	40° 40.49'	111° 56.37'	1306	EpiSensor	K2	Digital	ANSS
SCS	Syracuse City Cemetery Shop Syracuse, UT	SCS	EN[ZEN]	3	UU	41° 05.73'	112° 02.81'	1321	EpiSensor	K2	Digital	ANSS
SCY	Salem City Yard, Salem, UT	SCY	EN[ZEN]	3	UU	40° 03.47'	111° 41.14'	1386	Applied Mems	ANSS-130	Digital	ANSS
SGU	Sterling, UT	SGU	EHZ	1	UU	39° 10.94'	111° 38.68'	2357	18300	Masscomp	Analog	USGS
SHP	Sheep Range, NV	SHP	EHZ	1	NN	36° 30.33'	115° 09.61'	1590	*	*	Digital	UNR
SJF	South Jordan Fire Station, South Jordan, UT	SJF	EN[ZEN]	3	UU	40° 33.37'	111° 56.34'	1356	Applied Mems	ANSS-130	Digital	ANSS
SLC	University of Utah WBB Bldg Salt Lake City, UT	SLC	EL[EN]	2	UU	40° 45.97'	111° 50.86'	1436	WA Sim	Masscomp	Hardwired	USGS
			EN[ZEN]	3					FBA23	Masscomp		
SNO	Snow College, UT	SNO	EHZ	1	UU	39° 19.18'	111° 32.33'	2503	Ranger	Masscomp	Analog	Utah
SNUT	Stanbury North, UT	SNUT	EHZ	1	UU	40° 53.10'	112° 30.52'	1652	18300	Masscomp	Analog	USGS
SPR	Wildlife Resource Center Springville, UT	SPR	EN[ZEN]	3	UU	40° 10.94'	111° 36.71'	1379	EpiSensor	K2	Digital	ANSS
SPS	Stansbury Park Sewage Lagoon Stansbury Park, UT	SPS	EN[ZEN]	3	UU	40° 38.97'	112° 18.95'	1293	Applied Mems	ANSS-130	Digital	ANSS
SPU	South Promontory Point, UT	SPU	EN[ZEN]	3	UU	41° 18.52'	112° 26.95'	2086	EpiSensor	72A-08	Digital	ANSS
			HH[ZEN]	3					3ESP			
SRU	San Rafael Swell, UT	SRU	EHZ	1	UU	39° 06.65'	110° 31.43'	1804	S13	Masscomp	Analog	Utah
			HH[ZEN]	6					3T	72A-08	Digital	
			EN[ZEN]						EpiSensor			
SSC	Sandy Senior Center Sandy, UT	SSC	EN[ZEN]	3	UU	40° 34.89'	111° 51.35'	1414	EpiSensor	K2	Digital	ANSS
SUU	Santaquin Canyon, UT	SUU	EHZ	1	UU	39° 53.29'	111° 47.45'	2024	18300	Masscomp	Analog	USGS
TCU	Toone Canyon, UT	TCU	EN[ZEN]	3	UU	41° 07.04'	111° 24.47'	2269	EpiSensor	72A-08	Digital	ANSS
			HH[ZEN]	3					3ESP			
TCUT	Toone Canyon, UT	TCUT	EHZ	1	UU	41° 07.07'	111° 24.51'	2320	L4C	Masscomp	Analog	USGS
TMI	Taylor Mountain, ID	TMI	EHZ	1	IE	43° 18.30'	111° 55.08'	2179	*	*	Digital	INEEL
TMU	Trail Mountain, UT	TMU	HH[ZEN]	3	UU	39° 17.79'	111° 12.49'	2731	40T	72A-08	Digital	Utah
TM2		TM2	EH[ZEN]	3					S13			
TPMZ	Teepe Creek, MT	TPMT	EHZ	1	MB	44° 43.79'	111° 39.94'	2518	*	*	Analog	MBMT
TPNV	Topopah Spring, NV	TPNV	BH[ZEN]	3	US	36° 56.93'	116° 14.97'	1600	*	*	Digital	USGS
TPU	Thanksgiving Point, Lehi, UT	TPU	EN[ZEN]	3	UU	40° 25.81'	111° 54.13'	1383	EpiSensor	K2	Digital	ANSS

UURSN Code	Location	SEED Station	SEED Channel	No. of Channels	Network Code	Latitude	Longitude	Elevation (meters)	Sensor	Digitizer	Telemetry	Sponsor
TRC	Troy Canyon, NV	TRC	BHZ	1	NN	38° 20.98'	115° 35.11'	1815	*	*	Digital	UNR
TRS	Tooele County Radio Shop, Tooele, UT	TRS	EN[ZEN]	3	UU	40° 30.83'	112° 18.63'	1568	EpiSensor	K2	Digital	ANSS
TUC	Tucson, AZ	TUC	BH[ZEN]	3	US	32° 18.58'	110°47.05'	906	*	*	Digital	USGS
UHP	Utah Highway Patrol Farmington, UT	UHP	EN[ZEN]	3	UU	40° 59.47'	111° 53.88'	1295	EpiSensor	K2	Digital	ANSS
UTH	Uintah Town Hall, Uintah, UT	UTH	EN[ZEN]	3	UU	41° 08.65'	111° 55.52'	1389	EpiSensor	K2	Digital	ANSS
UUE	University of Utah EMCB Bldg, Salt Lake City, UT	UUE	EN[ZEN]	3	UU	40° 46.09'	111° 50.77'	1449	EpiSensor	K2	Digital	ANSS
VEC	Valley Emergency Communications Center West Valley City, UT	VEC	EN[ZEN]	3	UU	40° 39.21'	112° 01.95'	1480	EpiSensor	K2	Digital	ANSS
VES	Valley Elementary School, Huntsville, UT	VES	EN[ZEN]	3	UU	41° 15.72'	111° 46.20'	1501	Applied Mems	ANSS-130	Digital	ANSS
WBC	Weber Canyon, UT	WBC	EN[ZEN]	3	UU	41° 08.38'	111° 54.05'	1602	EpiSensor	K2	Digital	ANSS
WCF	Wellsville Fire Station, Wellsville, UT	WCF	EN[ZEN]	3	UU	41° 38.37'	111° 55.94'	1387	Applied Mems	ANSS-130	Digital	ANSS
WCN	Washoe, NV	WCN	HHZ	1	NN	39° 18.10'	119° 45.38'	1500	*	*	Digital	UNR
WCU	Willow Creek, UT	WCU	EHZ	1	UU	38° 57.88'	112° 05.44'	2673	18300	Masscomp	Analog	USGS
WES	Westminster College Salt Lake City, UT	WES	EN[ZEN]	3	UU	40° 43.97'	111° 51.26'	1341	EpiSensor	K2	Digital	ANSS
WHS	West High School Salt Lake City, UT	WHS	EN[ZEN]	3	UU	40° 46.51'	111° 53.93'	1301	EpiSensor	K2	Digital	ANSS
WMUT	West Mountain, UT	WMUT	EHZ	1	UU	40° 04.60'	111° 50.00'	1981	L4C	Masscomp	Analog	USGS
WRP	Water Reclamation Plant Salt Lake City, UT	WRP	EN[ZEN]	3	UU	40° 48.82'	111° 55.87'	1286	Applied Mems	ANSS-130	Digital	ANSS
WTU	Western Traverse Mountains, UT	WTU	EH[ZEN] ELZ	4	UU	40° 27.29'	111° 57.21'	1552	S13	Masscomp	Analog	USGS
			EN[ZEN]	3					Applied Mems	ANSS-130	Digital	ANSS
WUAZ	Wupatki, AZ	WUAZ	BH[ZEN]	3	US	35° 31.01'	111° 22.43'	1592	*	*	Digital	USGS
WVUT	Wellsville, UT	WVUT	EHZ	1	UU	41° 36.61'	111° 57.55'	1828	L4C	Masscomp	Analog	USGS
YCJ	Canyon Junction (YNP), WY	YCJ	EHZ	1	WY	44° 44.48'	110° 29.83'	2426	L4C	Masscomp	Analog	USGS
YDC	Denny Creek, MT	YDC	EHZ	1	WY	44° 42.51'	111° 14.60'	2025	L4C	Masscomp	Analog	USGS

UURSN Code	Location	SEED Station	SEED Channel	No. of Channels	Network Code	Latitude	Longitude	Elevation (meters)	Sensor	Digitizer	Telemetry	Sponsor
YFT	Old Faithful (YNP), WY	YFT	HH[ZEN]	3	WY	44° 27.05'	110° 50.24'	2292	40T	72A-07	Digital	USGS
			EHZ	1					L4C	None	None	
YGC	Grayling Creek, MT	YGC	EHZ	1	WY	44° 47.77'	111° 06.45'	2075	L4C	Masscomp	Analog	USGS
YHB	Horse Butte, MT	YHB	EHZ	1	WY	44° 45.07'	111° 11.71'	2157	L4C	Masscomp	Analog	USGS
YHH	Holmes Hill (YNP), WY	YHH	EH[ZEN]	3	WY	44° 47.30'	110° 51.03'	2717	S13	Masscomp	Analog	USGS
YJC	Joseph's Coat (YNP), WY	YJC	EHZ	1	WY	44° 45.33'	110° 20.95'	2684	S13	Masscomp	Analog	USGS
YLA	Lake Butte (YNP), WY	YLA	EHZ	1	WY	44° 30.76'	110° 16.12'	2580	L4C	Masscomp	Analog	USGS
YLT	Little Thumb Creek (YNP), WY	YLT	EHZ	1	WY	44° 26.25'	110° 35.28'	2439	L4C	Masscomp	Analog	USGS
YMC	*Maple Creek (YNP), WY*	*YMC*	*EHZ*	*1*	*WY*	*44° 45.53'*	*111° 00.41'*	*2073*	*S13*	*Masscomp*	*Analog*	*USGS*
YML	Mary Lake (YNP), WY	YML	EHZ	1	WY	44° 36.20'	110° 38.63'	2653	L4C	Masscomp	Analog	USGS
YMP	Mirror Plateau (YNP), WY	YMP	EH[ZEN]	3	WY	44° 44.38'	110° 09.40'	2774	S13	Masscomp	Analog	USGS
YMR	Madison River (YNP), WY	YMR	HH[ZEN]	3	WY	44° 40.12'	110° 57.90'	2149	40T	72A-07	Digital	USGS
YMS	Mount Sheridan (YNP), WY	YMS	EHZ	1	WY	44° 15.84'	110° 31.67'	3106	L4C	Masscomp	Analog	USGS
YMV	Mammoth Vault (YNP), WY	YMV	EHZ	1	WY	44° 58.42'	110° 41.33'	1829	L4C	Masscomp	Analog	USGS
YNR	Norris Junction (YNP), WY	YNR	HH[ZEN]	3	WY	44° 42.93'	110° 40.75'	2336	40T	RT-130	Digital	USGS
YPC	Pelican Cone (YNP), WY	YPC	EHZ	1	WY	44° 38.88'	110° 11.55'	2932	L4C	Masscomp	Analog	USGS
YPM	Purple Mountain (YNP), WY	YPM	EHZ	1	WY	44° 39.43'	110° 52.12'	2582	L4C	Masscomp	Analog	USGS
YPP	Pitchstone Plateau (YNP), WY	YPP	EHZ	1	WY	44° 16.26'	110° 48.27'	2707	S13	Masscomp	Analog	USGS
YSB	Soda Butte (YNP), WY	YSB	EHZ	1	WY	44° 53.04'	110° 09.06'	2072	L4C	Masscomp	Analog	USGS
YTP	The Promontory (YNP), WY	YTP	EHZ	1	WY	44° 23.51'	110° 17.10'	2384	L4	Masscomp	Analog	USGS
YWB	West Boundary (YNP), WY	YWB	EHZ	1	WY	44° 36.35'	111° 06.05'	2310	L4C	Masscomp	Analog	USGS

* Indicates station operated by another agency and recorded as part of University of Utah regional seismic network
† Name subject to change

Network Statistics: 490 data channels from 207 stations were being recorded at the end of this report period

EXPLANATION OF TABLE

UURSN Code: Station code used in routine processing. Due to processing software limitations, the station code may not be the station code used by the original operator. For multi-component stations, the vertical, east-west, and north-south high gain (low gain) components are identified by an appended Z(V), E(L), and N(M), respectively, in UUSS phase files.

Location: General description of station location. YNP = Yellowstone National Park.

SEED Station: The SEED (Standard for the Exchange of Earthquake Data) station code used by the original operator.

SEED Channel: The SEED format uses three letters to name seismic channels. See <<http://www.iris.edu/manuals/SEED_appA.htm>> for information about the SEED channel naming convention. Relevant sections are reproduced below. In the SEED convention, each letter describes one aspect of the instrumentation and its digitization. The first letter specifies the general sampling rate and the response band of the instrument. Band codes used in this table include:

Band Code	Band Type	Sample Rate	Corner Period
E	Extremely short period	= 80 Hertz	< 10 seconds
H	High broadband	= 80 Hertz	= 10 seconds
B	Broadband	= 10 to < 80 Hertz	=10 seconds
S	Short period	= 10 to < 80 Hertz	< 10 seconds

The second letter specifies the family to which the sensor belongs. Sensor families used in this table are:

Instrument Code	Description
H	High gain seismometer
L	Low gain seismometer
N	Accelerometer

The third letter specifies the physical configuration of the members of a multiple axis instrument package. Channel orientations used in this table are:

Z E N Traditional (Vertical, East-West, North-South)

Number of Channels: Total number of waveform channels recorded.

Network Code: The FDSN (Federation of Digital Seismographic Networks) registered network code. See <<http://www.iris.edu/stations/networks.txt>> for information about registered seismograph network codes. Network codes referenced in this table:

Network Code	Network name; Network operator or responsible organization
AR	Northern Arizona Seismic Network, Northern Arizona University
LB	Leo Brady Network; Sandia National Laboratory
IE	Idaho National Engineering and Environmental Laboratory

IU	IRIS/USGS Network; USGS Albuquerque Seismological Laboratory
MB	Montana Regional Seismic Network; Montana Bureau of Mines and Geology
NN	Western Great Basin; University of Nevada, Reno
NP	National Strong Motion Program; U.S. Geological Survey
RC	Formerly Ricks College Network; Ricks College, Idaho; now BYU-Idaho
RE	U.S. Bureau of Reclamation Seismic Networks; U.S. Bureau of Reclamation, Denver Federal Center
UU	University of Utah Regional Network; University of Utah
US	US National Network; USGS National Earthquake Information Center
WY	Yellowstone Wyoming Seismic Network; University of Utah

Latitude, Longitude: Sensor location in degrees and decimal minutes; North latitude, West longitude.

Elevation: Sensor altitude in meters above sea level.

Sensor	Description
L4, L4C	Mark Products short-period seismometer
S13, 18300	Geotech S13 or 18300 short-period seismometer
Ranger	Kinemetrics Ranger short-period seismometer
40T	Guralp CMG-40T broadband seismometer
3T	Guralp CMG-3T broadband seismometer
3ESP	Guralp CMG-3ESP broadband seismometer
FBA23	Kinemetrics accelerometer
EpiSensor	Kinemetrics accelerometer
Applied Mems	Applied Mems accelerometer
WA Sim	Wood-Anderson displacement seismometer (electronically simulated)

Digitizer	Description
Masscomp	Concurrent Computer Corporation (formerly Masscomp) 7200C computer (with 12-bit digitizer)
K2	Kinemetrics Altus Series K2 (19-bit resolution field digitizer)
Etna	Kinemetrics Altus Series Etna (19-bit resolution field digitizer)
72A-07	Refraction Technology (REF TEK) model 72A-07 (24-bit field digitizer)
72A-08	Refraction Technology (REF TEK) model 72A-08 (24-bit field digitizer)
ANSS-130	Refraction Technology (REF TEK) model 130-ANSS/02 (24-bit resolution field digitizer)
RT-130	Refraction Technology (REF TEK) model RT-130 (24-bit resolution field digitizer)

Telemetry	Description
Analog	Data transmission is analog along part of the transmission pathway
Digital	Data are converted to digital form at the station site
Hardwired	Direct physical cable connection to computer recording system
None	On-site recording system

Sponsor (or Operator for stations marked by * in preceding columns)

USGS	U.S. Geological Survey
Utah	State of Utah
ANSS	Advanced National Seismic System
INEEL	Idaho National Engineering and Environmental Laboratory
USBR	U.S. Bureau of Reclamation
LLNL	Lawrence Livermore National Laboratory
Sandia	Sandia National Laboratory
BYU-I	Brigham Young University, Idaho (formerly Ricks College)
MBMT	Montana Bureau of Mines and Geology
NSMP	National Strong Motion Program, U.S. Geological Survey
UNR	University of Nevada, Reno

NETWORK CHANGES DURING JANUARY 1, 2004–JANUARY 31, 2005 (Italicized rows in Table)

February 25, 2004	Begin continuous recording of station OPS components EN[ZEN]
March 23, 2004	Begin recording continuous SAC files of station CRMT component EHZ
April 14, 2004	Begin continuous recording of station MOR components EN[ZEN]
July 2, 2004	Begin continuous recording of station HEB component EHZ
August 27, 2004	REF TEK ANSS-130 at station LCU replaced with a Kinemetrics K2
September 1, 2004	Seismometer Mark Products L-4c replaced with Geotech S-13 and VCO replaced at station YMC
December 1, 2004	Begin onsite recording of station CAP, components EN[ZEN]
December 9, 2004	Begin continuous recording of stations ARGU and ROA, component EHZ

APPENDIX B

Response to “20 Questions”
Network Performance Report to ANSS
University of Utah Regional/Urban Seismic Network
March 1, 2004

Response to “20 Questions”
University of Utah Regional/Urban Seismic Network
(for Utah Region)

March 1, 2004

1. What is the minimum magnitude detection threshold for your entire region?

$M \geq 3.0$ (because of sparse station coverage in distal parts of Utah region, notably eastern Utah)

2. What is the minimum magnitude detection threshold for the best instrumented part of your region?

$M \geq 1.5$ (along main seismic belt in Wasatch Front area)

3. What is the typical hypocentral location accuracy for earthquakes occurring within your region? Is it the same for automated vs reviewed?

Based on a review of earthquake locations from July 1, 2003, to the present, epicentral accuracy is similar for automated and reviewed locations: median ERH for automated Earthworm locations = 1.0 km (vs. 0.8 km for reviewed locations).

Typically, only a small fraction of earthquake locations in the Utah region have good focal-depth control (DMIN $\geq$ DEPTH or 5.0 km and ERZ $\geq$ 2.0 km) because of station spacing. Median ERZ for automated locations = 8.6 km (vs. 2.1 km for reviewed locations using S-wave picks).

4. Does your region report automated earthquake locations into QDDS? If yes, how long does it take?

Yes, for $M \geq 3.0$ in the Utah/Yellowstone regions or $M \geq 2.5$ in the Wasatch Front Urban corridor. Typically takes seconds for automatic message generation within Earthworm. Assumes a live Internet connection is available to get the QDDS message out.

5. Does your region report analyst-reviewed earthquake locations for all quakes into QDDS (i.e., the little ones)? If yes, what is the typical processing delay?

Yes. All earthquakes are submitted to QDDS following analyst review. Delay is typically next business day. If there is significant earthquake activity, then the analyst processes the largest events first. The delay can then be a week or longer until everything is caught up (depending on staff resources at the time).

6. Does your region have 7X24 duty seismologists who review real-time earthquake locations above some magnitude? If yes, what magnitude and how long does it take?

Yes. Real-time locations/magnitudes for earthquakes $\geq$ M 3.5 in the Utah and Yellowstone monitoring regions are human-reviewed as quickly as feasible. Review can be completed in 15 minutes but occasionally takes up to one hour due to problems caused by idiosyncrasies and bugs in our Earthworm system. Currently we have to share 7X24 duty-seismologist responsibilities among 2.75 FTE seismologists. We recognize the need to create an enlarged pool of trained responders and are trying to streamline procedures to ensure consistently rapid review.

7. Describe the velocity model used to locate earthquakes in your region (1-D?, multiple models?, 3-D?). Does it differ for automated vs reviewed?

Three different 1-D velocity models are used for analyst-reviewed locations in the Utah region. A single 1-D velocity model is used for analyst-reviewed locations in the Yellowstone region. Automatic solutions use a single Utah 1-D model for all solutions, including Yellowstone. We may start using more 1-D models once we begin using Hypo2000 for routine processing.

8. What program does your region use to locate earthquakes? Does it differ for automated vs reviewed?

Automated locations are computed using Hypoinverse-2000 (version that comes with Earthworm). We implement whatever location program is in the Earthworm release at the time. Analyst-reviewed locations are computed using Hypoinverse-1978.

9. What magnitudes does your region routinely report in real time (Md, ML, Me, Mw, Ms etc.)? How long does it take to compute them?

Automatic solutions are reported as M_L if available; otherwise, as coda-duration magnitude, M_C (calibrated to M_L). Both magnitudes are calculated on the fly in a matter of seconds.

10. Does your region archive phase information at a datacenter? If yes, how long is the delay to report? In what year does archiving begin?

Phase data from July 1962 through 1988 were submitted to NOAA some time ago. Submission of post-1989 data has been awaiting a major revision (near complete) of our entire earthquake catalog.

11. Does your region archive summary (i.e., earthquake catalog) information at a public datacenter? If yes, how long is the delay to report? In what year does archiving begin?

Yes. Utah and Yellowstone region catalogs are automatically submitted to the CNSS/ANSS catalog four times per day (Monday through Friday). The submitted catalogs date back to 1962 for Utah and 1973 for Yellowstone. Earthquake catalogs are also posted on our own Web site.

12. Does your region archive event waveforms at a public datacenter? If yes, describe what type of channels (e.g., EH, HH, HN) and how long is the delay to report? In what year does archiving begin?

Archived event waveforms date back to 1981. All digitally-recorded waveforms from stations we maintain and operate (channel types EH, EN, HH, EL) have been sent to the IRIS DMC. We stopped sending segmented waveform data to IRIS when we began submitting continuous data streams.

13. Do you archive continuous waveforms at a public datacenter? If yes, describe which channels and how long is the delay to report? In what year does archiving begin?

Continuous waveform data from all stations we maintain and operate (EH, EN, HH, EL) have been submitted to the IRIS DMC on a daily basis since June 2002. Currently, the IRIS DMC retrieves data from our Earthworm System wave tanks several times per day. Using a different system, submission of continuous waveform data from our broadband stations began on June 19, 2000, and on April 19, 2001, for continuous waveform data from our strong-motion stations.

14. If your region archives waveforms, does it supply supporting instrument response metadata to support generation waveforms in SEED? For all *waveforms?*

Yes, all UUSS response data is at IRIS and supports SEED. Archive starts in 1981.

15. Does your region compute focal mechanisms? If yes, what type (first motion, moment tensor). In real-time? Do you archive them at a public datacenter?

We do not compute focal mechanisms in real-time. Focal mechanisms based on P-wave first motions are computed in a research mode and are not currently archived at a public data center.

16. Does your region automatically distribute email to the public in near real-time for significant events?   Do you offer a website where they can sign up?

Automatic email alerts are distributed to (1) the Utah Division of Emergency Services and Homeland Security and (2) the Utah Geological Survey following the creation of a ShakeMap. This occurs automatically for all events in the Wasatch Front urban corridor with $M \geq 3.0$. We do not have a subscription option on our Website, nor do we distribute email for events outside of the Wasatch Front area.

17. Does your region automatically distribute alphanumeric pages to the public in near real-time for significant events? Do you offer a website where they can sign up?

No.

18. Does your region automatically compute ShakeMaps and make them publicly available? If so, how long does it take?

Yes. Takes less than 5 minutes to generate. Posted publicly on our UUSS Web site within the 5-minute window, assuming that we are not overloaded with hits. Also submitted to USGS within 5 minutes. Assumes a live Internet connection.

19. Does your region operate a fault-tolerant system (e.g., redundant computers, UPS, back-up generator with lots of fuel)?

We operate redundant computer systems—including dual Earthworm systems and a parallel Concurrent 7200-C computer system running HAWK processing software. We have a UPS system that provides a few to several hours of backup power, depending on human intervention to conserve power consumption. We do not have a back-up generator and are relying on increased ANSS funding to achieve full “hardening” of our network operations center.

20. What does your region do with the [strong-motion] data recorded on ANSS instruments? Do you use it for routine locations? Do you make it available to the engineering community through something like the COSMOS datacenter or the CSMIP Engineering Data Center? Do you use the data in constructing ShakeMaps?

Data from strong-motion (SM) stations installed on rock are merged with data from broadband and short-period stations for use by the analyst in routine locations (data from non-rock SM stations may be retrieved and used for significant events to improve hypocentral resolution). Similarly, Earthworm uses SM data from rock sites for picking purposes and for computing M_L. Continuous waveforms are sent to the IRIS DMC. SM data are used to construct ShakeMaps and are also used for research purposes. For example, SM data from our ANSS network were used to calculate peak dynamic stresses accompanying surface waves generated by the Denali Fault earthquake. Data are also being used in a separately funded NEHRP study to evaluate site amplification and resonant frequencies in the Salt Lake Valley.

The COSMOS Data Center has a minimum magnitude (~*M* 5) for data they are willing to archive. We have not recorded a local earthquake large enough to meet their threshold, but we plan to submit SM data from future such events to the COSMOS archive for availability to the engineering community.

DISTRIBUTION OF ANNUAL TECHNICAL REPORT

	Number of Copies
Dr. Michael L. Blanpied U.S. Geological Survey External Research 12201 Sunrise Valley Drive, MS 905A Reston, Virginia 20192	1 unbound 5 copies Abstract & Non-technical Summary 1 electronic copy
Dr. Walter J. Arabasz Principal Investigator	1
Dr. Robert B. Smith Co-Principal Investigator	1
Dr. James C. Pechmann Co-Investigator	1
Dr. Kristine L. Pankow Co-Investigator	1
Relu Burlacu Co-Investigator	1
Office of Sponsored Projects University of Utah [summary only]	1
File Copies Administrative Assistant University of Utah Seismograph Stations	2